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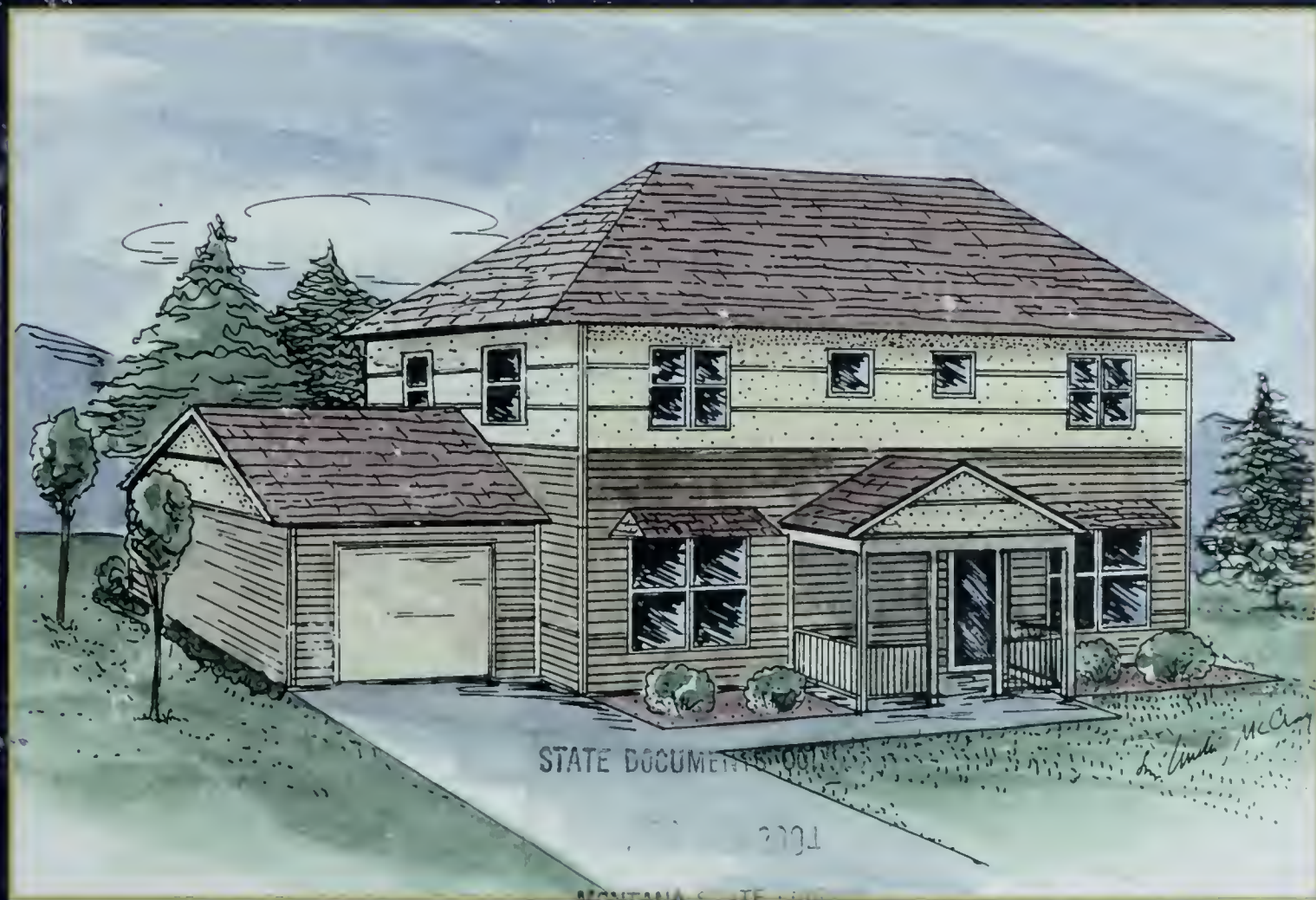
MONTANA HOUSING SOLUTIONS

DESIGNING FOR COMFORT & QUALITY

**COMPLIMENTS
OF THE**



VALUE \$10.00



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MONTANA
Housing Solutions
DESIGNING FOR COMFORT & QUALITY



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We also thank the architects who took time away from their busy schedules to develop the affordable and energy efficient housing designs in this book.

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THINKING OF BUILDING A NEW HOUSE?

Many individuals building their first house are often overwhelmed with how to get started. There seems to be an endless number of decisions that need to be made before you move in. This book is for everyone planning to build a house in Montana who faces this challenge. It gives an overview of the basics of how to finance a home, select the right building site and builder and design and build the home with energy efficiency and comfort in mind.

It also offers a selection of small, affordable house plans that have been designed for Montana. These energy efficient house plans are responsive to Montana's climate, landscapes, and character. These house plans cost less to build, provide both comfort and efficiency and fit the local landscape.

BEFORE YOU BEGIN

In order to successfully build your new home, it's important to learn as much as you can about the home building process. The more you know about what you are about to do, the better your home-building experience will be.

Building a home is the largest, single investment of money that most families will

ever make. Before spending time, and especially money, on a home building project, it's a good idea to make sure you are prepared. The four questions that follow are among the most important when determining if you should consider building a home.

1. In recent years, have you had a solid employment record?
2. Do you have an established and favorable credit profile?
3. Have you saved the money for a down payment?
4. Can you afford monthly mortgage payments for the house you want?

Few loans are for the full purchase price of a house. Instead, a lender will insist you contribute some portion of your own funds as a down payment. Today, buyers can sometimes pay as little as 3% down. As a typical example, for a \$90,000 home, a 3% down payment would be \$2,700. If you do not have enough money saved for a down payment, assistance might be available through a relative

"THE STRENGTH
OF A NATION LIES
IN THE HOMES
OF ITS PEOPLE."

ABRAHAM LINCOLN

In addition to the four basic questions, here are some things to consider before deciding to build a home:

- Where do you want to build?
- Are there covenants, restrictions or zoning issues related to the use of the property ?
- What do you want to build and why?
- How long do you plan to live there?
- Do you need any special accommodations?
- How involved do you want to be?
- Do you have the time to undertake a home building project?
- What is your time frame?
- How will a new home impact school, social and recreational activities, and work commutes?

or government sponsored first-time homebuyer programs.

Generally, lenders limit the amount of your monthly mortgage payment to about 28% of your gross monthly income. The amount of your total monthly debt is limited to 36% of your income. Using these lender guidelines, you can estimate the monthly mortgage payments that you can afford. The amount of these payments will depend on current interest rates. You may want to get pre-qualified for a loan by a lender to determine more precisely the amount a lender will provide you for a mortgage.

HOME FINANCING

One method of getting a general estimate of what is affordable assumes that a family can afford a home that costs up to two and one-half times its annual gross household income. Annual gross income is the amount you make before taxes are deducted. For example, a family with an annual income of \$40,000 might be able to afford a home that costs about \$100,000. While this method provides a “ball park” estimate, because it is so simple it can also be quite inaccurate. Your actual buying

power will depend on the following two factors:

- How much you have available for the down payment and closing costs.
- How much a financial institution will agree to lend you.

DOWN PAYMENT

Depending on the lender and type of loan, you may be able to get a mortgage with as little as 3% or 5% down. However, putting less than 20% down usually means that you will be required to purchase mortgage insurance. Mortgage insurance helps protect the lending institution in case you fail to make payments on your mortgage. Typically, the cost of mortgage insurance will be added to your monthly mortgage payments and to your closing costs. In many cases, your lender will require you to have two months of mortgage payments saved up as a cash reserve when you apply for your mortgage.

CLOSING COSTS

In addition to the down payment, you will need to consider closing costs. The closing costs are the costs and fees of getting a mortgage loan. Closing costs generally range from 3% to 6% of the amount of the mortgage loan.

PROPERTY APPRAISAL

Another major factor that determines how much you can borrow is the estimated market value of the property. The lender will have the property evaluated by an independent, licensed appraiser. The lender will consider the appraised value of both the building site and your house design in determining a maximum loan amount.

TYPES OF LOANS

There are a number of agencies that help homebuyers afford the purchase of a home. For example the Federal Housing Administration (FHA), the Veterans Administration (VA), and Rural Development insure or guarantee mortgage loans made by lenders according to government guidelines in case of default.



MONTHLY HOUSING EXPENSES

The amount of money you can borrow is based in part on your ability or capacity to pay for your monthly housing costs. For mortgage qualification purposes, your housing expense consists of:

- Mortgage Principal and Interest Payments
- Property Taxes
- Homeowner's Insurance Premium
- Mortgage Insurance Premium, if any.
- Home Owner Association Fees, if any.
- Special Improvement District Fees, if any.

While the lender doesn't include them as an expense, remember that there will be annual home maintenance costs of approximately 1% of the purchase price.

These are valuable programs for people with limited funds because they allow lower down payments (3% to 5%) than traditional loans (10% to 20%). Fannie Mae now offers 97% loans as a standard product with such mortgage insurance. Be sure to ask lenders about special loan programs made available by the Montana Board of Housing, Rural Housing, Fannie Mae and other organizations.

CONSTRUCTION LOAN

In addition to the mortgage loan that finances most of the cost of the home once it is built, there will nearly always need to be a short term construction loan to finance costs during construction. In some cases, the homebuilding contractor will obtain or provide the construction financing. When the homeowner obtains the construction financing, lenders generally require a down payment of 10% of the total housing project costs that include land, site improvements, and construction. In addition, the homeowner will need to pay construction loan interest during the construction phase.

SELECTING A HOUSE PLAN

There are many considerations in choosing the house plan that is best for you. You will need to pay attention to a wide range of details to determine what you need, want, and can afford in your new home. When you look at home plans, determine whether they will suit your lifestyle. Is there enough living space? Are there enough bedrooms and bathrooms? What about storage space? Do you need space for a home office? What about the amount of upkeep required both inside and out? There will be things that you absolutely need and things that you will definitely not want to include in your new home.

As you examine the plans, you may find it helpful to write down your specific likes and dislikes regarding the plans that catch your eye. This can help you more clearly define your design preferences, and will better prepare you for meetings with a builder. Another hands-on way to discover the kind of design you want is by touring model homes, speculative homes under construction or your local parade of homes. By doing so, you can

experience the real-life livability of homes' with designs and square footage similar to what you are considering. At the same time, you can discover what your local builders have to offer in the way of quality and workmanship.

Compile your likes and dislikes of specific design elements in this book and from visiting model homes, and prepare your own definition of the ideal home - one that would best meet your immediate, as well as future needs. Begin by making a wish list that includes a specific statement, such as: "Our home has to be a one-level design with a master suite that's well-separated from three other bedrooms."

Consider whether your needs are likely to change over time. Do you foresee your family growing, or perhaps caring for an aging parent? How about future job demands? Do the designs you're considering provide a space suitable for a home office? You may also want to consider a home plan with expansion possibilities. Several of the plans in this book are designed for expansion. To keep costs down initially, garages may be added later and basements or attic rooms may be left unfinished. If you plan to add rooms or a garage, make sure there is enough space on your site





for such expansion and that such additions are permitted by your local jurisdiction. Conversely, you may not intend to live in the house for a long time. In that case, you may want to consider the resale potential of various home designs.

Good design does not have to be costly. Any home's design should first be livable. Secondly, to optimize your investment, every inch of square footage should be utilized to the best of its potential. For example, quick access from the garage to the kitchen helps when bringing in groceries, while easy access from the kitchen to the dining room is helpful for carrying hot dishes.

Be practical. Remember, very few people can afford to build their dream house, especially the first time. Be realistic about what you can afford and understand that you can probably build the home you need but not necessarily the ideal home you want.

Ultimately, only you are qualified to define the "perfect" design for you. Experts can offer suggestions and opinions, and builders can showcase their finest efforts in parades and model homes, but it is you who must weigh all the options and decide, "This is the home for me!"

MATERIAL & DESIGN OPTIONS

After choosing the design that best suits your needs, all of the materials and finishes that you want and are within your budget will need to be identified. You will need to work with the contractor or subcontractors you have chosen to build your home to specify the materials and finishes. In order to get the things that you want the way you really want them, be sure that everything is in writing with as much detail as necessary. Your construction specifications should be clear, complete, and accurate. Aside from their importance in the design and construction of your new house, these documents will be needed to create an accurate budget. You cannot realistically estimate how much your house will cost to build, until you know exactly what you are trying to construct.

COST ESTIMATING

Developing accurate cost estimates is perhaps one of the most challenging parts of the home building process. As you develop your cost



New Home Construction Cost Break Out

— *Materials & Labor*
55 - 60%

— *Finished Lot or Land Costs*
25 - 30%

Financing Costs ~ 2 - 5%
Overhead & General Expenses ~ 5 - 7%
Marketing Costs ~ 2 - 5%
Sales Commission ~ 3 - 6%

— *Profit ~ 8 - 10%*

estimates they will evolve from very general square footage estimates with a wide margin of error to more precise estimates for specified materials and labor. Thorough and continually refined cost estimates are essential for a successful home building project.

While there are many individual components that go into the cost of a new home, the three major factors affecting total cost are land, material and labor. In your cost estimate, you will need to allocate costs to the land or building site and to the construction of the home. The information below breaks down the cost of a detached, single-family home based on national averages from a recent Builders Survey of Construction Costs - a survey of 50 nationwide builders in 37 metro areas, conducted by the National Association of Home Builders, and averages from the Marshall Valuation Service - a manual used by licensed appraisers.

These figures are national averages and may not accurately represent your local market conditions. Building costs range considerably across Montana due to substantial differences in the costs for building materials and labor, building site conditions, the local housing market, and other factors.

When figuring out how much a new home will cost, the common practice has been to price the home out on a “cost per square foot” basis. Buyers often take a home plan, either one from a plan book or one they have custom-designed, to various builders for estimates or bids. In recent years, with the variety, type and quality of amenities rapidly increasing, many builders have found the “cost per square foot” analysis to be inadequate. The problem with pricing a home on such a basis is that the different bids given by builders may not be “apples for apples” comparisons. For example, one builder may offer better quality or higher allowances for floor coverings, appliances, lighting fixtures, and so on. Also, many features that builders consider their “standard” amenities often vary greatly. In the same vein, the specific brand and quality of features you choose to put in your home will also dramatically affect the price.

With such a wide range in costs, the only way to be sure that your home building budget is reasonable is to develop or obtain a cost estimate for the specific home you plan to build. Of course, in order to do that, you will need to select the plans and specifications.

So, it’s best to start by figuring out how

much you can afford to spend, then be realistic about the size of the house you need, and then decide what and where you can afford to build.

After you have a good idea of your budget you can look in the real estate section of your local newspaper for homes that are in your price-range. Sometimes, the advertisements will provide you with prices and square foot descriptions from which you can develop a square foot cost estimate. If possible, tour model homes in order to see room sizes, the type of finishes, and the quality of workmanship that you should expect in that price-range.

You may also want to check with local mortgage bankers, real estate agents, or friends who have recently built a new home or addition to see what type of “ballpark” numbers they can provide. Local contractors and homebuilders associations might be able to quote “average” homebuilding costs and figures. However, before you put too much faith in “average” numbers, keep in mind that the only house that you really care about is the one that you are about to build. Remember that building prices can range from \$65 to \$150 or more per square foot, so the difference between the lowest figure and the highest





is substantial. Regardless of exactly how you finally come up with the numbers, be sure to take the time to review your finances, prepare a reasonable budget, and produce an accurate construction estimate for the specific home that you are about to build.

When you are ready to take the plans you have selected to builders for cost estimates, make sure the estimates you receive are apples for apples comparisons. Find out as much as you can about each builder's product. Find out as much specific information as you can about standard allowances, finish grades of carpet and lighting fixtures, paint, brick, plumbing and heating systems.

SELECTING A BUILDING SITE

Deciding exactly where to build your new home will depend on a wide variety of factors. The decision will probably be influenced more by your budget and the supply of suitable building sites in your area than any other factors.

It's also helpful to talk with an experienced homebuilder when looking for the land

or lot on which to build your home. An experienced builder can help you prepare a preliminary budget for the home that you want and need, and may help prevent you from purchasing property on which it will be very expensive to build. Each potential building site may have distinct opportunities and perhaps some hidden problems. At a minimum, it must be technically possible to construct a home with adequate access, water and sewer service, and utilities on the site. Additionally, land use regulations must permit the home to be built.

In other words, can your home be built on the site at a reasonable cost? Walk the site with your builder to make sure that building your home there is possible for your budget.

BUILDING SITE CONSIDERATIONS

Land characteristics will affect your ability to place the home on the site and the cost of development, so it's important to know about soil conditions, slope and grade, and access issues. It's also important to know if any zoning ordinances or regulations exist that

So, it's best to start by figuring out how much you can afford to spend, then be realistic about the size of the house you need, and then decide what and where you can afford to build.

When you are ready to take the plans you have selected to builders for cost estimates, make sure the estimates you receive are apples for apples comparisons.



might restrict the development of your home on the property. These regulations might restrict how much of the property can be covered by a home, its height, how far it must be set back from the property line or roadway, and protection of existing trees and landscape. You'll want to know about any zoning and proposed development of adjacent or nearby properties, such as new roadways, apartment complexes or commercial construction.

SELECTING A BUILDER

You should choose your builder as carefully as you choose your home plans and building site for your home. Locating and hiring a qualified builder is one of the first steps toward quality control of your home building project. A builder can help you develop initial cost estimates and select the plan and building site that is within your budget. Therefore, it's helpful to select the builder you intend to work with early in the process.

There are two basic methods of contracting to have your home built. The first is to hire a builder or general contractor to be responsible for the complete construction of your home. In the second method, the owner acts as the

builder and hires subcontractors from the various building trades (plumbers, electricians, carpenters, etc.) to construct the components of the house. Sometimes there can be a mix of the two methods. For example, the owner may be responsible for the development of a well and septic system with the general contractor responsible for the construction of the home. Unless you are highly experienced in construction and the home building process, it is highly recommended that you choose a qualified homebuilder to be responsible for the construction of your home.

A good place to start your search for a qualified homebuilder is by contacting your local building contractor association. You can also call your local Chamber of Commerce to ask them for recommendations. Talk to acquaintances that have recently contracted to build a new home. Ask builders for the addresses of their recently built homes and subdivisions. Visit homes they have built and talk with the owners. You can also visit local model homes. Often the builders are there, and you can talk to them to see if they would fit your needs. When examining a home, look at the quality of the construction. Ask the builder or the builder's representative a lot of





questions. The more people you talk with, the more likely it is that the information you get about a builder will be accurate.

One important consideration for selecting a builder is the warranty provided on the home. Most builders offer some form of written warranty. Many builders back their own warranties on workmanship and materials, typically for one year. Other builders offer warranties backed by an insurance company. Ask to see a copy of the builder's warranty. Find out from each builder what kind of service you can expect after the sale. Typically, a builder makes two service calls during the first year after you move in to repair nonemergency problems covered by your warranty. The first call is usually 30 to 120 days after the move-in, and the second is around the eleventh month—right before any one-year warranties on workmanship and materials expire.

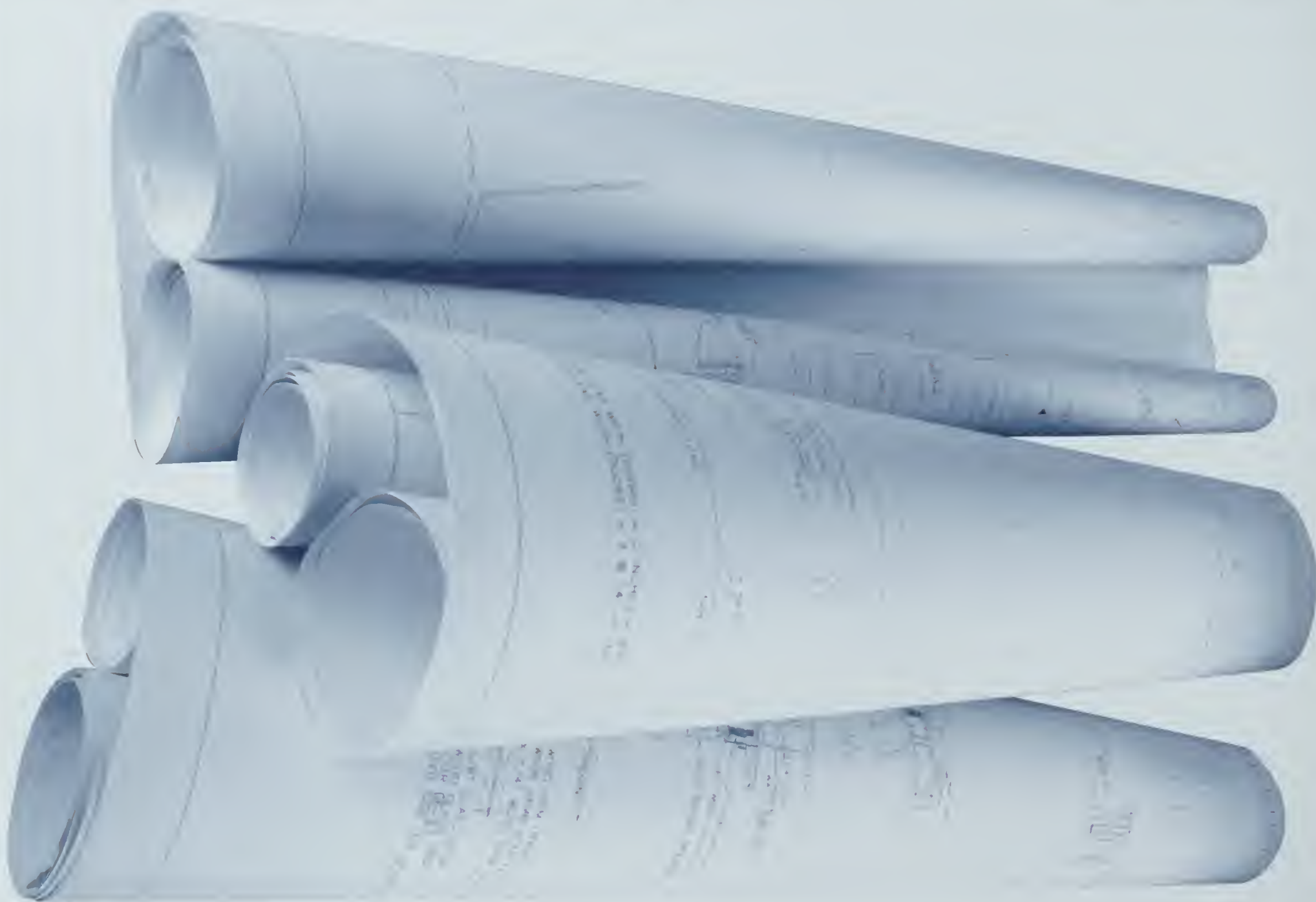
THE CONSTRUCTION CONTRACT

You will need a formal contract between you and the builder you choose to build your home. The contract will include construction documents that provide detailed drawings and specifications for your project. Additionally, since a new home contract is first and foremost a legally binding agreement, it is recommended that you retain a lawyer to review the agreement so that it is complete, accurate, fair, and enforceable, for all parties.

TYPICAL CONTENT OF A HOME BUILDING CONTRACT

- Names, addresses & contact procedures
- Date of contract
- Property description
- Amount of contract
- Terms of financing
- Contractor's mark-up on labor & materials
- Payment terms, procedures and schedule
- Use of lien release or dual-signer check
- Insurance requirements
- Responsibility for permit application (who pays)
- Start date and definition
- Substantial completion date and definition
- Reference to plans, blueprints, and specifications
- Material allowances
- Change order procedures and pricing
- Inspection schedule
- Authorized delay conditions
- Penalties or fines
- Access to the construction site
- Owner, lender & third party inspections
- Treatment of unforeseen contingencies
- Methods to solve disputes
- Warranties and service policies
- Any documents required by state or local laws





MONTANA HOUSING SOLUTIONS HOUSE PLANS

During the last decade it has become increasingly difficult for the average Montana family to build an affordable home. The house plans included in this book are all designed with affordability and energy efficiency in mind.

Some of the designs are suitable for smaller lots that reduce land development costs and thus increase affordability. Many of the designers of these house plans have found ways to reduce building costs by adopting new construction practices, such as frost protected shallow foundations or structural insulated panels. All of the house plans meet or exceed the requirements of the Model Energy Code for Montana.

Details on ordering plans can be obtained by contacting the Montana Building Industry Association, 1717 11th Avenue, Helena, MT 59601. Phone (406) 442-4479





PLAN CODE: PLAN 1
 DESIGNER: BJERKE ARCHITECTS
 SQUARE FOOTAGE: 994 SQ. FT.
 BEDROOMS: 2
 SIZE: 20 FT. X 32 FT.

PLAN 1

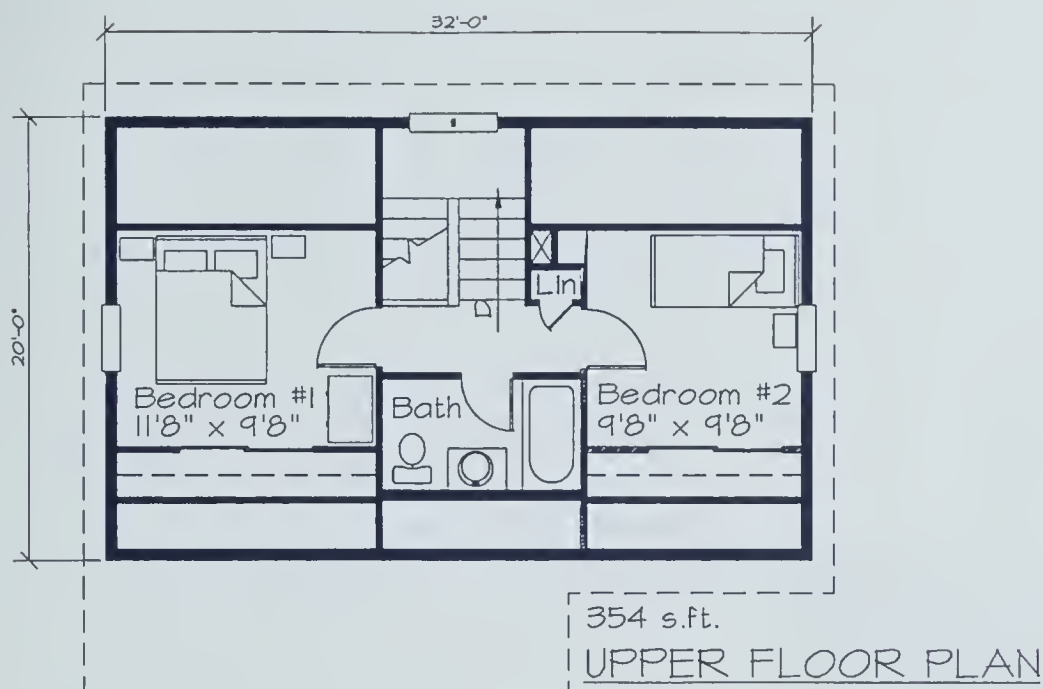
MYRDAL

Inspired by the compact mountain homes of Norway, this two-story plan moves the private bedroom spaces to the second floor, creating larger living spaces on the main floor with cross ventilation and natural light. Ample exterior exposure on the main floor offers options for exterior decks and patio doors.

Customized window seats or glass details are possible at the stair landing. The central hallway and stair area provides good air flow for an alternative heat source such as a wood or gas stove on the main floor. If the budget allows, the central stair could become a design element or use simple screen walls in lieu of wood or metal balusters.

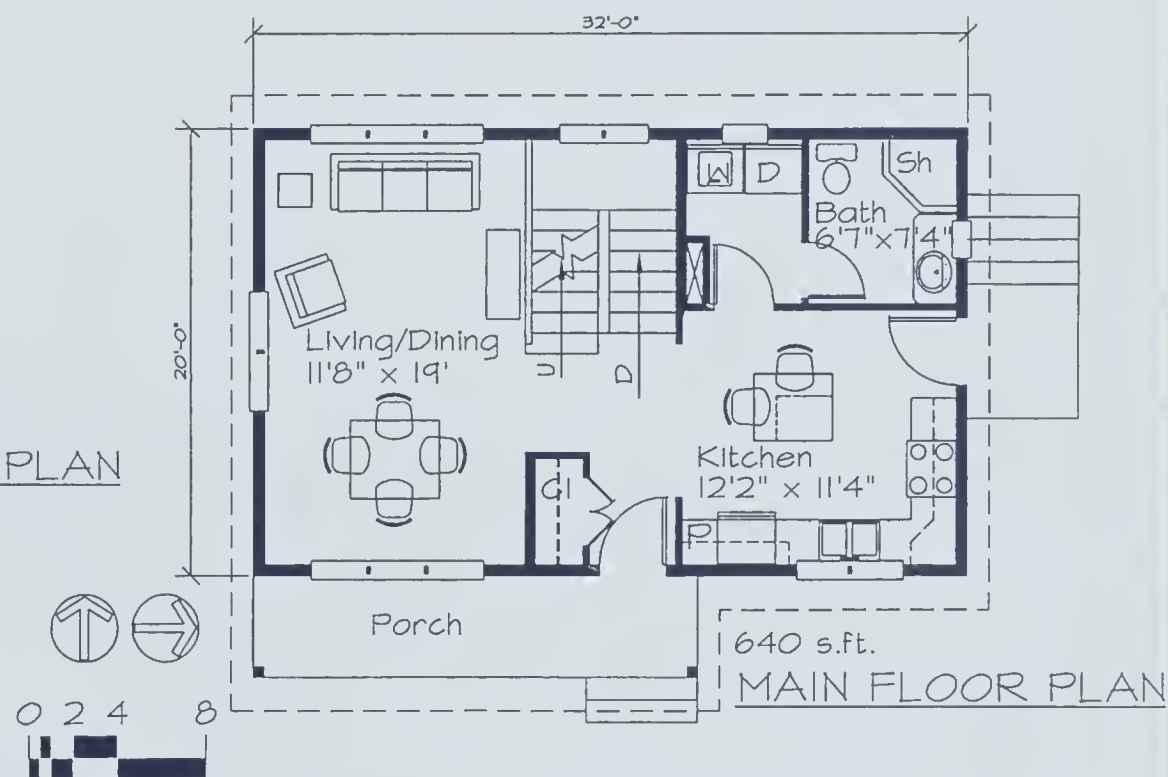
Two dining areas are provided. The area adjacent to the living area may also become a den or study. A four-foot module used for the building exterior footprint allows efficient use of building materials.

This plan is suitable for an in-town or rural lot. A sloping lot can allow additional bed-



rooms in the basement. The furnace and hot water heater is located in the basement. If the basement option is eliminated, this equipment could be provided on the main floor.

A second entrance through the kitchen is provided for ease of access with groceries, and for access to the detached garage. In neighborhoods with alleys, the garage could be accessed via the alley. In neighborhoods without alleys, this house is narrow enough for driveway access along the side of the house to a garage located at the side or rear of the lot.



AFFORDABILITY AND ENERGY FEATURES

COMPACT
CROSS-VENTILATION AND NATURAL LIGHT
GOOD AIR FLOW FOR ALTERNATIVE HEAT SOURCE
EFFICIENT USE OF BUILDING MATERIALS

PLAN 2

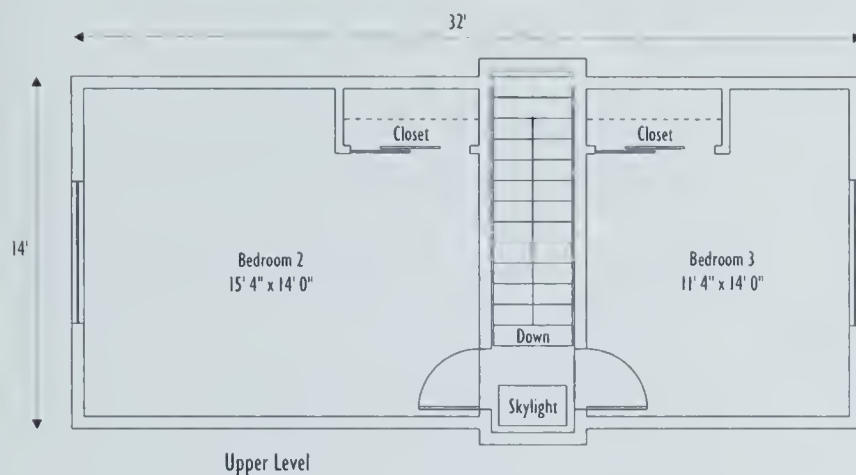


PLAN CODE: PLAN 2
DESIGNER: THOMAS R. WOOD, AIA, ARCHITECT
SQUARE FOOTAGE: 1213 SQ. FT.
BEDROOMS: 3
SIZE: 24 FT. X 32 FT.

This compact, flexible, three-bedroom house minimizes exposed surface area and takes advantage of efficient construction practices. The plan works well on a flat site or on a site that slopes away from the street. The optimal location would be on a site where the street is on the north property line. This maximizes southern exposure for direct solar gain. A full basement or daylight basement could be easily added to this plan.

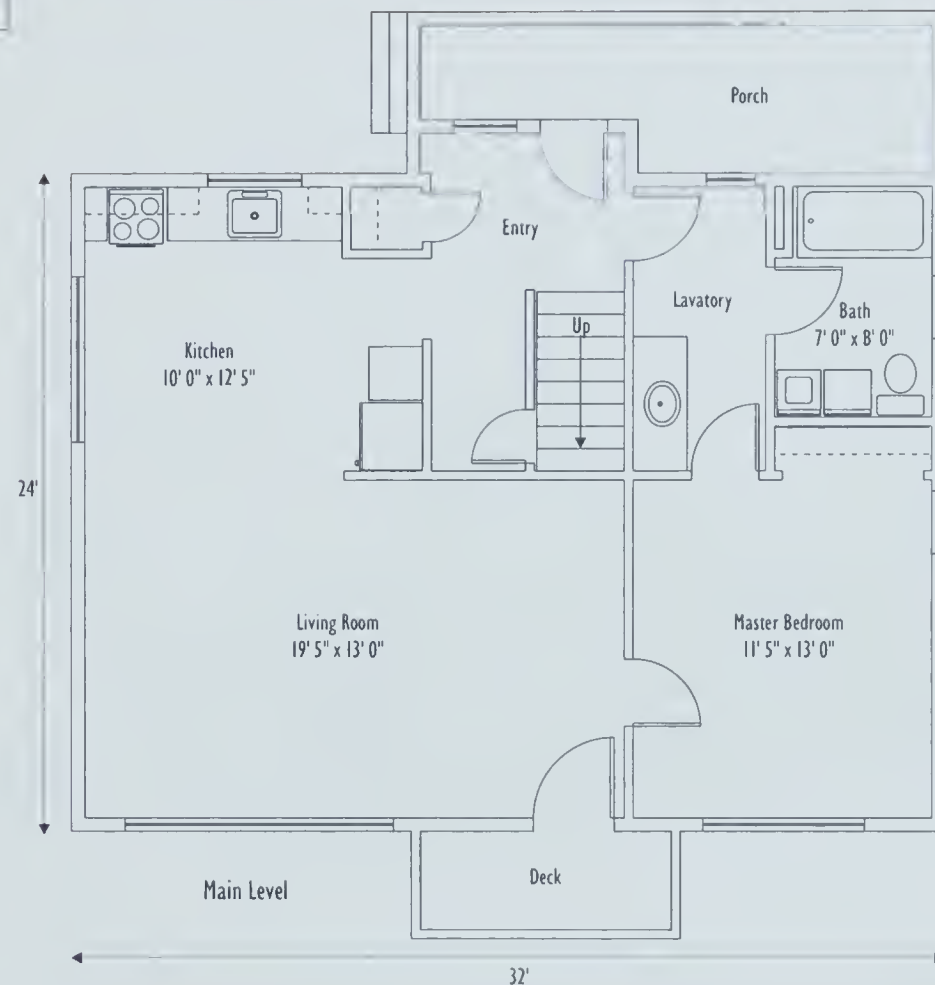
The ground level consists of an open plan living area and a master bedroom suite. The lavatory area is directly accessible from the master bedroom and the hall. A separate bathing and toilet room allows greater flexibility for family use. The upper level can be arranged as two bedrooms or a bedroom and recreation room or office. A detached or attached garage could also be added to this plan depending on the site conditions. The kitchen takes advantage of compact appliances to save space.

The house is designed on a 2-foot planning module for ease of construction and minimal waste. The second floor and roof framing is combined in a single "room in truss" component



for economical and fast construction. This truss has a raised heel for better insulation at the top plate and it provides adequate attic space ventilation.

The compact and well-insulated shell of this house will protect the occupants from winter blasts and the heat of summer. The 12/12 roof pitch oriented toward the south provides an ideal surface for solar hot water or photovoltaic panels if the homeowner desires. A radiant floor hot water heating system provides even temperatures and allows the sun to help heat the home through the generous south-facing living room and master bedroom windows.



AFFORDABILITY AND ENERGY FEATURES

COMPACT

ENCOURAGES EFFICIENT CONSTRUCTION AND MINIMAL WASTE OF MATERIALS
 "ROOM IN TRUSS" DESIGN PROVIDES FOR ECONOMICAL AND FAST CONSTRUCTION
 PITCH OF SOUTH-FACING ROOF IDEAL FOR AUXILIARY SOLAR EQUIPMENT
 RADIANT FLOOR HOT WATER HEATING SYSTEM



PLAN CODE: PLAN 3
 DESIGNER: DT ARCHITECTURE
 SQUARE FOOTAGE: 1194
 BEDROOMS: 3
 SIZE: 23 FT. X 42 FT.

PLAN 3

For the family of three or four, this design provides a unique but affordable housing option. With sensitivity to solar orientation and space layout, this design brings a sense of openness and elegance to a small house.

Visual connections between floors provide natural daylighting as well as a sense of openness to the spaces. Opportunities exist for varying the degree of this openness. For instance, the back bedroom could be opened to the living room below if desired. This room may make a good play-loft or office for a family not in need of the extra bedroom.

This house is designed for a small city lot and integrates the indoor and the out-of-doors by carving out space along the south side of the plan for outdoor living and landscaping. This outdoor space is visually drawn into the interior where spaces are carved to create a curved interior wall with roomy entry area and dining space.

Energy conservation measures have been taken into consideration by providing the opportunity for winter solar heat gain from the southern exposure. Plan orientation is critical to the energy efficiency of this design. While the plan can be mirrored such

that the front entry occurs near the dining area, the intended south side of the house must remain oriented to the south. Concrete floors provide the mass necessary for storing heat and avoiding temperature fluctuations. Structural insulated panels provide the R-value needed in the roof to avoid unnecessary heat loss and provide labor efficiency in construction.

A tower in the center of the house provides multiple opportunities for energy-efficient temperature control within the house. A fan placed in the tower acts as a whole-house fan, evacuating hot air from the upper floor of the house at night and drawing cool air into the lower floors. In the winter, the tower is closed and the fan keeps the rising warm air circulating in the occupied spaces of the house.

This house incorporates a frost-protected shallow foundation system. This system, accepted by CABO Building Code, reduces costs for excavation and concrete by permitting builders to dig footings just 12-16 inches deep and installing monolithic slabs instead of extending foundations to below the frost line. The insulated slab also reduces heat loss from the building.



AFFORDABILITY AND ENERGY FEATURES

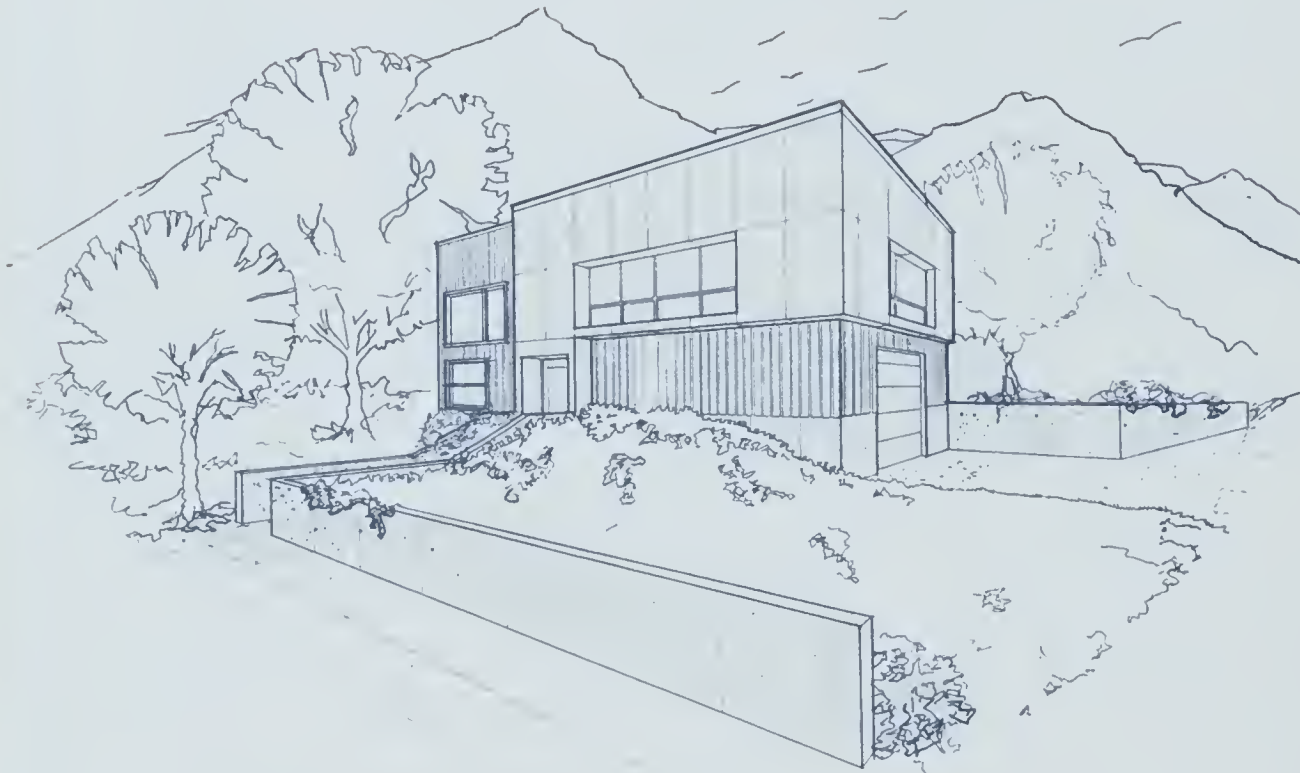
SOUTHERN EXPOSURE PROVIDES WINTER SOLAR HEAT GAIN
 CONCRETE FLOORS STORE HEAT
 AND AVOID TEMPERATURE FLUCTUATIONS
 STRUCTURAL INSULATED PANELS
 LABOR-EFFICIENT DESIGN
 TOWER STRUCTURE ALLOWS TEMPERATURE CONTROL
 FROST-PROTECTED SHALLOW FOUNDATION SYSTEM

PLAN 4

MONTANA TRADITION

The Montana Tradition is based on the principles long held valuable by our early settlers. The home uses common materials with a compact plan and a simple shape creating a house that can be constructed with ease. From foundation to roof, ease of construction is emphasized. The foundation is kept simple, without jogs or turns that increase costs. The roof does not require the extra framing and flashing of dormers, hip roofs, gables, skylights and other complexities that may cause problems with snow, ice and water.

Simplicity is a Montana tradition. Because the house is only seventeen feet wide, it can accommodate almost any lot size. Even with an attached garage, a necessity throughout Montana, the home occupies only 884 square feet of land. This minimal footprint allows room for gardening, a children's play area, outdoor storage and room for a pet. In addition to our close ties

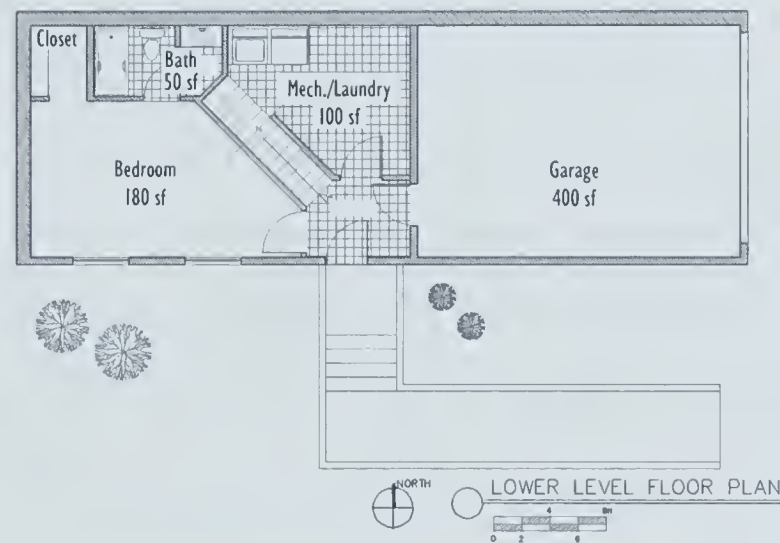
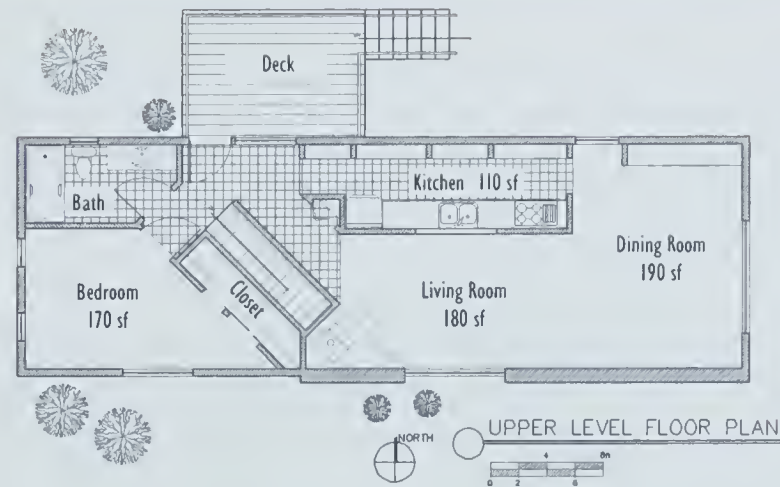


PLAN CODE: PLAN 4
DESIGNER: LLEWELLYN ARCHITECTS
SQUARE FOOTAGE: 1,300
BEDROOMS: 2
SIZE: 17 FT. X 52 FT.

to the land, the Montana Tradition is built upon distant views and our magnificent Big Sky.

With the main living on the upper level, our most valuable commodities such as distant views and open skylines, are brought into every room. To allow for solar gain, more than 90 percent of the windows are designed to face south and east. Simultaneously, the north side has minimal openings and is partially buried. Utilizing the best of our Montana tradition, the home is both responsive to our Montana climate and the magnificent landscape.

Traditional board-on-board wood siding, steel, and board formed concrete has been combined to keep maintenance at a minimum. The interior spatial feeling belies the square footage. The vaulted ceiling provides open views to the south, and creates a light, welcoming feeling with the interiors. The Montana Tradition is revived, not in style, but in substance for the twenty-first century.



AFFORDABILITY AND ENERGY FEATURES

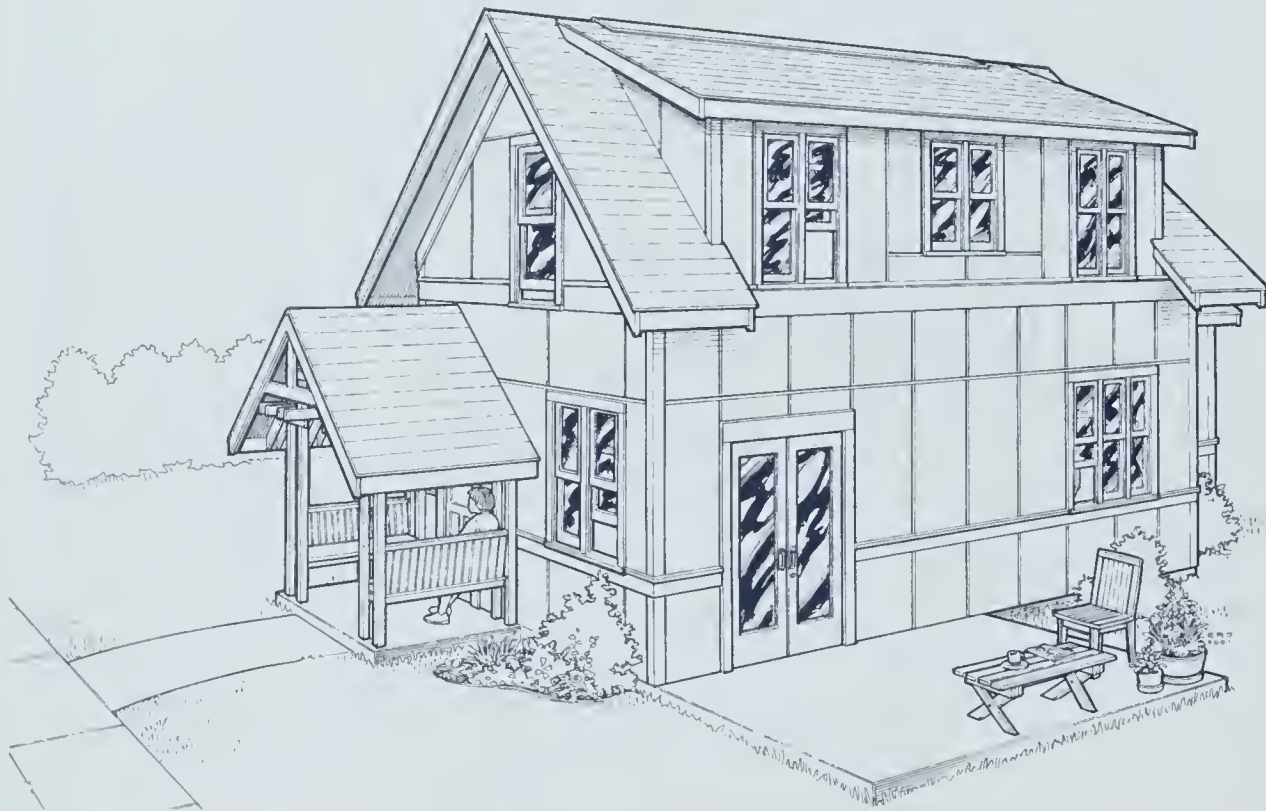
EASE OF CONSTRUCTION

SIMPLE DESIGN TO REDUCE COSTS

WINDOWS DESIGNED TO FACE SOUTH AND EAST FOR SOLAR GAIN

PARTIALLY-BURIED NORTH SIDE TO REDUCE HEAT LOSS

PLAN 5

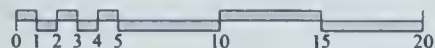
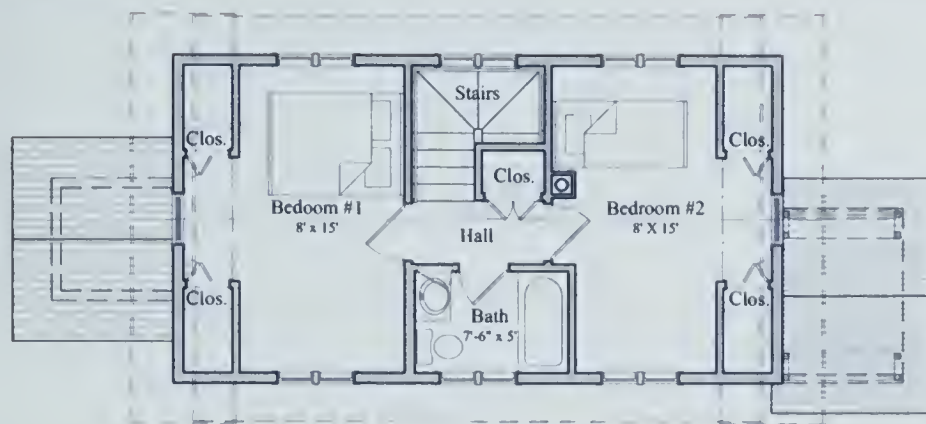


PLAN CODE: PLAN 5
DESIGNER: ADLER ARCHITECTS, INC.
SQUARE FOOTAGE: 1,000
BEDROOMS: 2
SIZE: 16 FT. X 42 FT.

The Montana Shotgun, a western adaptation in the tradition of the New Orleans Shotgun House heritage, is a small house with 1,000 square feet of space. It features an open floor plan, which accommodates two bedrooms and 1 1/2 baths. Spaces are grouped logically with the living areas below and the private areas above. The simplicity of the floor plan anticipates future additions and ensures effective thermal performance based upon many of the principals of its forerunner.

Though it can be adapted to almost any site, this house fits the toughest of sites, specifically the narrow urban infill lot. It accommodates stringent setback requirements and fits the historic patterns and styles of Montana neighborhoods. The plan adapts easily to any orientation by locating the front entry porch to any exterior wall of the living room or even across from the stairs to create a foyer. Building the Montana Shotgun in an established neighborhood eliminates the need for providing new sewer and water systems.

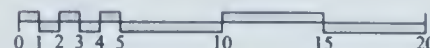
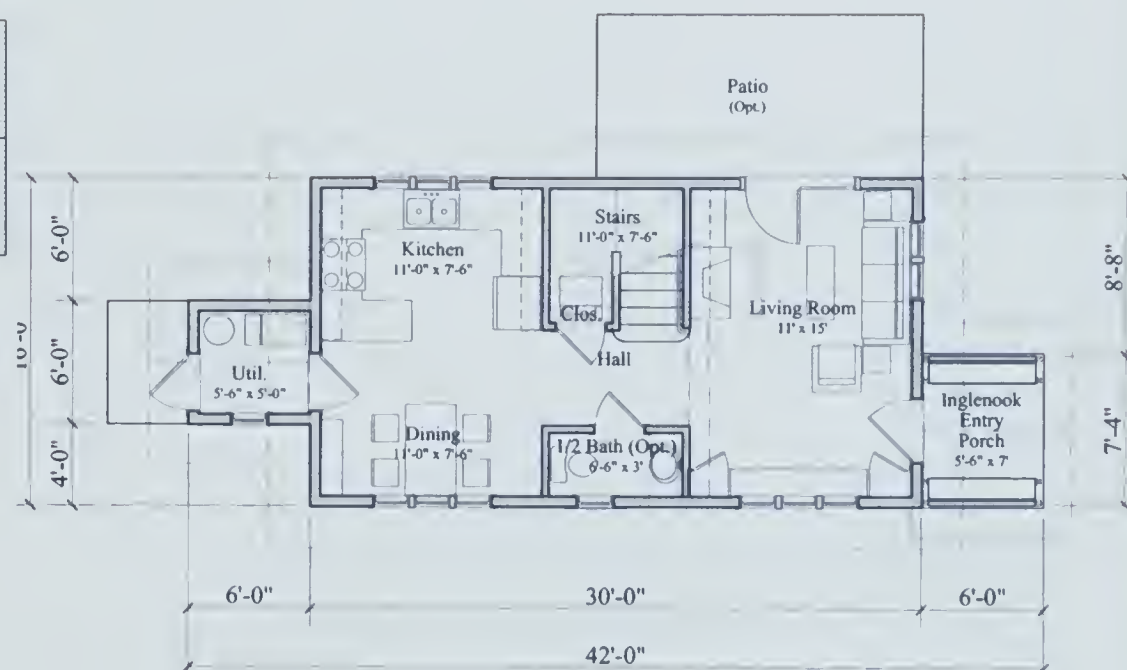
The Montana Shotgun meets or exceeds the



SECOND FLOOR PLAN

standards of the Model Energy Code. The open floor plan allows for solar gain with heat sink capabilities. The windows are taller than usual for improved daylighting. The arrangement of rooms allows for effective cross-ventilation cooling in every living area.

Construction is value-engineered to save on materials and labor and can be carried out with purely conventional technology. This allows for sweat equity (owner's option) and eliminates any surprises in subcontracting bids, should they be unfamiliar with specialized systems. Should the owner wish to employ other building systems such as panelized products, pre-fabrication or even straw-bale methods, the geometry is simple enough to easily adapt.



FIRST FLOOR PLAN

AFFORDABILITY AND ENERGY FEATURES

- EFFECTIVE USE OF SPACE (FEWER SQUARE FEET)
- VALUE-ENGINEERED, CONVENTIONAL BUILDING METHODS
- SIMPLE CONSTRUCTION / GEOMETRY
- FROST PROTECTED SHALLOW FOUNDATION OPTION
- HEADERLESS WINDOWS (LABOR SAVINGS)
- THERMAL PERFORMANCE / LOWER ENERGY COSTS

PLAN 6

AN AFFORDABLE AND ACCESSIBLE HOUSE FOR MONTANA

In the Big Sky Country we have a strong desire to closely tie our homes to nature. This house design is based on a dwelling that cultivates family activities and nature easily.

This three bedroom accessible dwelling has 1,600 square feet of interior space and 230 square feet of covered terraces, all under one roof. Ideally located on a south-facing level site, the house can be modified to accommodate a sloping site with the inclusion of a crawl space or basement. If placed on a narrow lot, perpendicular to the street, an additional structural bay at the carport end of the dwelling allows generous covered parking

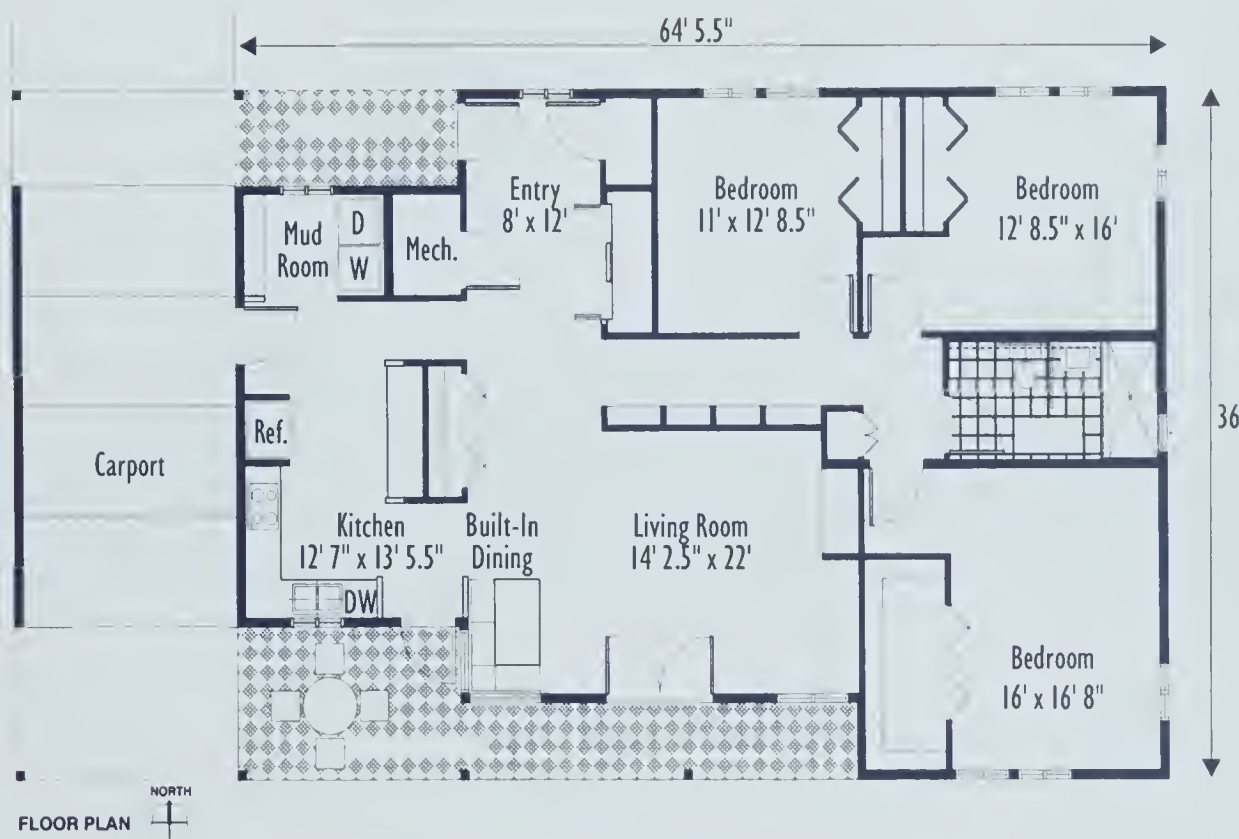


PLAN CODE: PLAN 6
DESIGNER: PAUL BLUMENTHAL, ARCHITECT
SQUARE FOOTAGE: 1,600
BEDROOMS: 3
SIZE: 32 FT. X 52 FT.

for two vehicles and a covered walkway to the formal entry.

The accessible house includes amenities such as an open, flexible floor plan with formal entry, operable casement windows, French doors, generous closet space, a mudroom with a laundry folding counter, built-in dining alcove, spacious bathroom, and a covered terrace dining area. The house design allows people who use a wheel chair to enjoy both the interior and exterior of the home comfortably.

The house is built using standard residential construction practices. Construction elements include standard residential framing, cementitious concrete siding and an asphalt shingle roof that contribute to low maintenance and a fire rated dwelling. The structure's walls, ceiling and floor slab are all insulated for energy savings.



AFFORDABILITY AND ENERGY FEATURES

STANDARD RESIDENTIAL MATERIALS USED TO REDUCE COST
WALLS, CEILING AND FLOOR SLAB ALL INSULATED



PLAN CODE: PLAN 7
 DESIGNER: BOB HIERS, AIA
 SQUARE FOOTAGE: 1176
 BEDROOMS: 3
 SIZE: 28 X 42

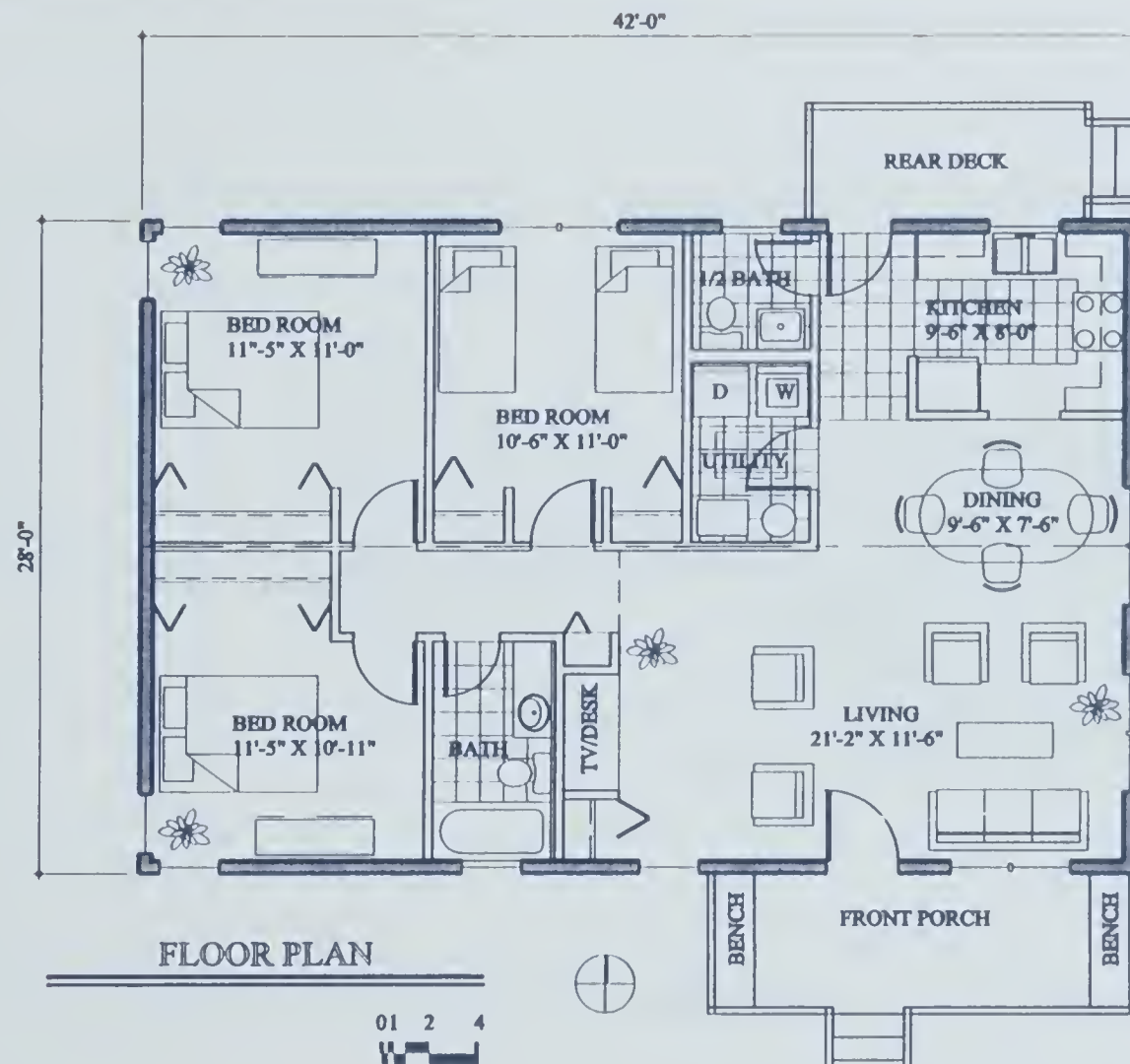
PLAN 7

STRUCTURAL INSULATED PANEL HOME

This home design features structural insulated panels (SIP's) to achieve high levels of energy efficiency and affordability. The central area of the house has views in three directions to make the living space seem larger. Cathedral ceilings in the kitchen, dining room and living room add to the spaciousness.

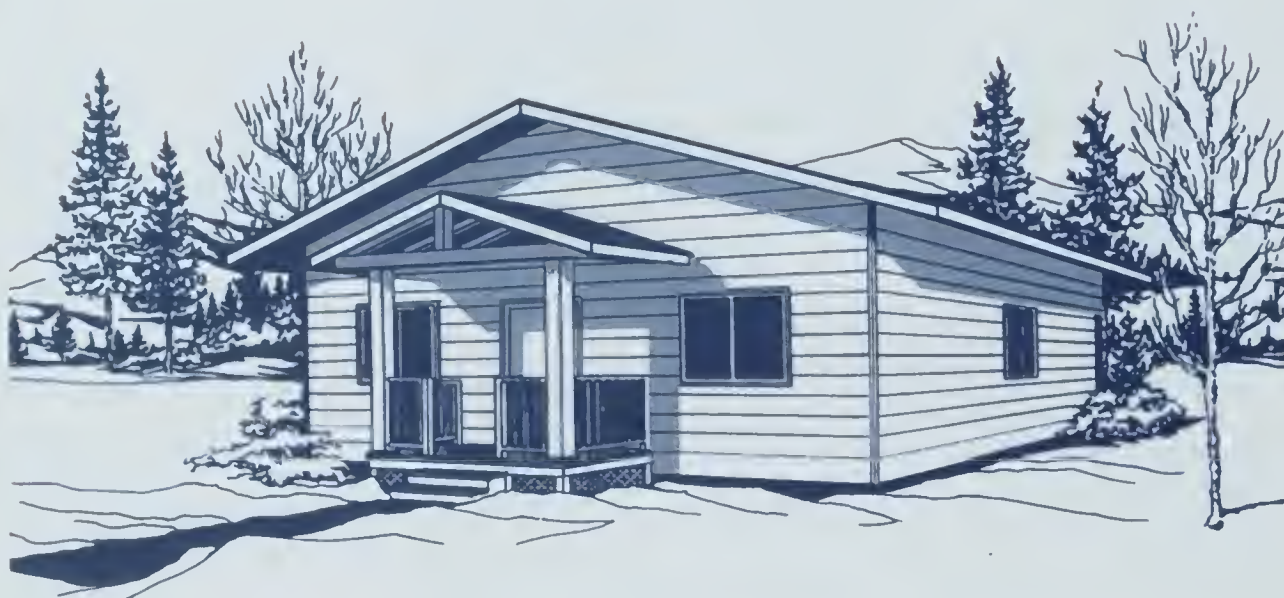
All roof penetrations for mechanical and plumbing vents are concealed in the vented cupolas at the ridge line. Additional storage area is made available over all closets because of the cathedral ceilings.

Structural insulated panels are used both in the roof and wall construction of this home. The roof panels are 10 1/4 inches thick with an R-value of 37. Wall panels are 6 1/2 inches thick and have an R-value of 22.6. All ductwork for this home design can be incorporated within the heated envelope of the home, thereby reducing energy losses compared to conventional construction.



AFFORDABILITY AND ENERGY FEATURES

ALL DUCTWORK WITHIN HEATED ENVELOPE
 STRUCTURAL INSULATED PANELS (SIPS) OFFER OUTSTANDING INSULATION
 SIPS ALSO REDUCE LABOR AND CONSTRUCTION TIME



PLAN CODE: PLAN 8
 DESIGNER: NATIONAL AFFORDABLE HOUSING NETWORK
 SQUARE FOOTAGE: 1120
 BEDROOMS: 3
 SIZE: 28 FT. X 40 FT.

PLAN 8

HIGH PERFORMANCE HOUSE PLAN

This plan has several high performance construction and ventilation features that work together to reduce space heating costs to a minimum. The design is based in part on detailed field research from the Montana Superinsulation Project.

Nominal insulation values in the walls are R-40, R-60 in the ceilings, and R-25 in the floor. High performance window glazing and R-11 exterior doors complete the insulation package. The design also features airtight construction and whole-house heat recovery ventilation. The heat recovery ventilation system is integrated into the design of the home and can provide a continuous supply of fresh air to the occupants. Sealed combustion water and space heating systems are also included.

The plan set includes 16 pages of complete construction details, materials list and resources for product selection.



AFFORDABILITY AND ENERGY FEATURES

HIGH R-FACTOR INSULATION IN WALLS, CEILING, FLOOR AND EXTERIOR DOORS
 HIGH-PERFORMANCE WINDOW GLAZING REDUCES HEAT LOSS
 AIR-TIGHT CONSTRUCTION AND WHOLE-HOUSE HEAT RECOVERY VENTILATION
 SEALED COMBUSTION WATER AND SPACE HEATING SYSTEMS



PLAN CODE: PLAN 9
 DESIGNER: NATIONAL AFFORDABLE HOUSING NETWORK
 SQUARE FOOTAGE: 1092
 BEDROOMS: 3
 SIZE: 26 FT. X 42 FT.

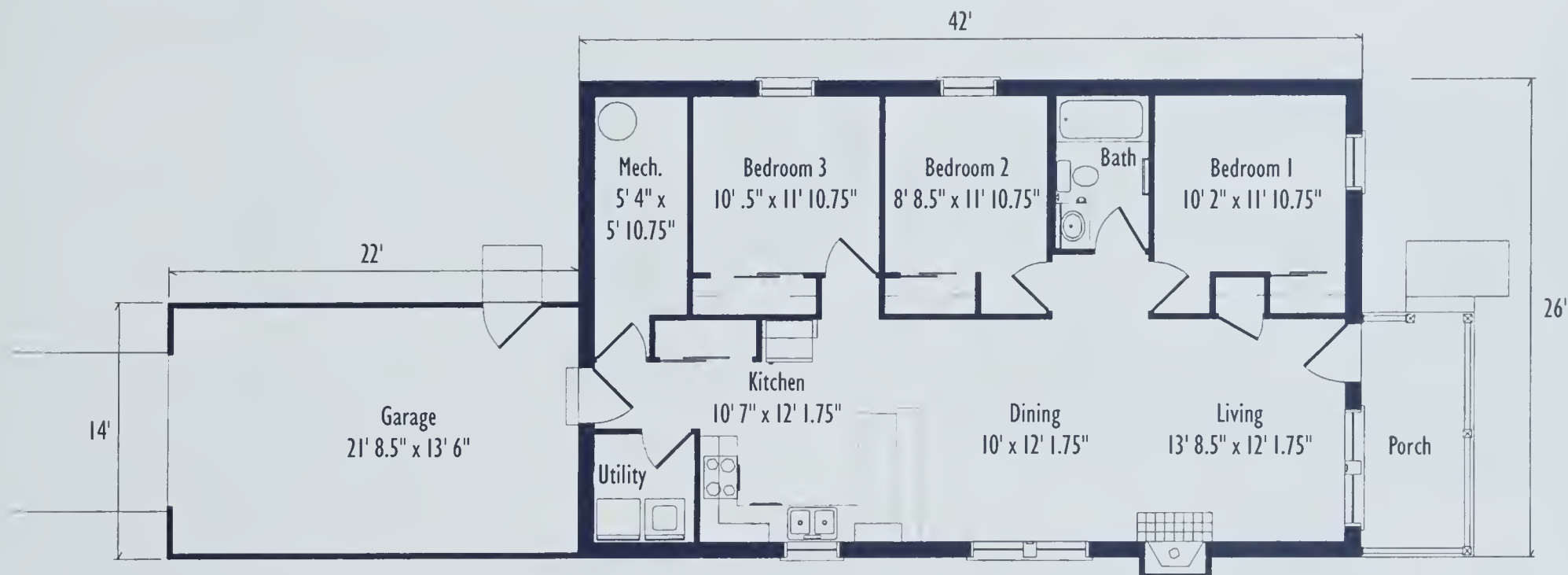
PLAN 9

HIGH PERFORMANCE HOUSE PLAN

This plan has several high performance construction and ventilation features that work together to reduce space heating costs to a minimum. The design is based in part on detailed field research from the Montana Superinsulation Project.

Nominal insulation values in the walls are R-40, R-60 in the ceilings, and R-25 in the floor. High performance window glazing and R-11 exterior doors complete the insulation package. The design also features airtight construction and whole-house heat recovery ventilation. The heat recovery ventilation system is integrated into the design of the home and can provide a continuous supply of fresh air to the occupants. A sealed combustion gas fireplace heats the home.

The plan set includes 24 pages of complete construction details, materials list and resources for product selection.



AFFORDABILITY AND ENERGY FEATURES

HIGH R-FACTOR INSULATION IN WALLS, CEILING, FLOOR AND EXTERIOR DOORS
 HIGH-PERFORMANCE WINDOW GLAZING REDUCES HEAT LOSS
 AIR-TIGHT CONSTRUCTION AND WHOLE-HOUSE HEAT RECOVERY VENTILATION
 SEALED COMBUSTION GAS FIREPLACE



PLAN 10

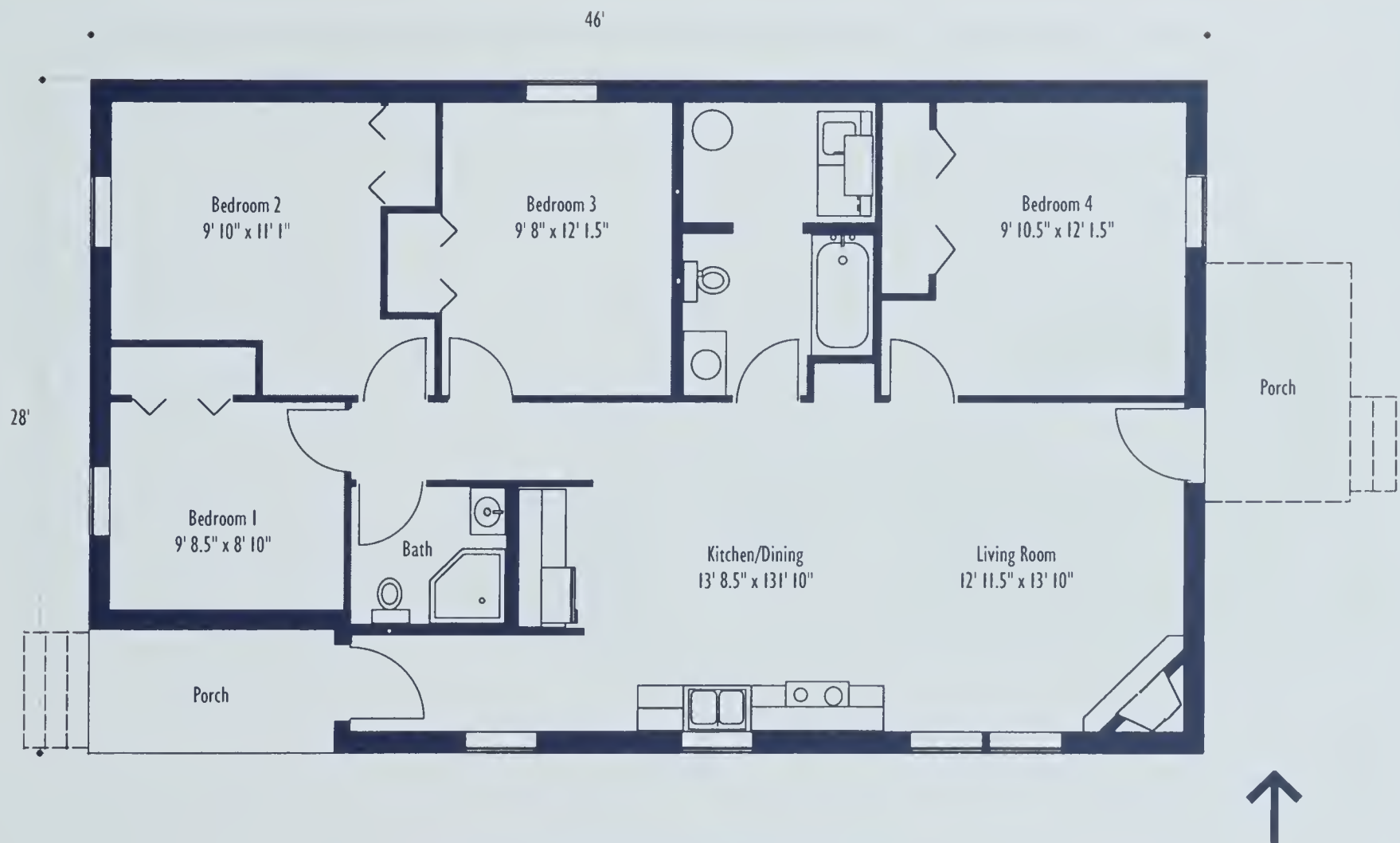
HIGH PERFORMANCE HOUSE PLAN

This plan has several high performance construction and ventilation features that work together to reduce space heating costs to a minimum. The design is based in part on detailed field research from the Montana Superinsulation Project.

Nominal insulation values in the walls are R-40, R-60 in the ceilings, and R-25 in the floor. High performance window glazing and R-11 exterior doors complete the insulation package. The design also features airtight construction and whole-house heat recovery ventilation. The heat recovery ventilation system is integrated into the design of the home and can provide a continuous supply of fresh air to the occupants. A sealed combustion gas fireplace heats the home.

The plan set includes 17 pages of complete construction details, materials list and resources for product selection.

PLAN CODE: PLAN 10
DESIGNER: NATIONAL AFFORDABLE HOUSING NETWORK
SQUARE FOOTAGE: 1238
BEDROOMS: 4
SIZE: 28 FT. X 46 FT.



AFFORDABILITY AND ENERGY FEATURES

HIGH R-FACTOR INSULATION IN WALLS, CEILING, FLOOR AND EXTERIOR DOORS
 AIR-TIGHT CONSTRUCTION AND WHOLE-HOUSE HEAT RECOVERY VENTILATION
 SEALED COMBUSTION GAS FIREPLACE

PLAN 11

PRYOR

To make housing truly affordable both the front-end costs and long term operating costs must be considered. This design is uncomplicated to build and economical to maintain and operate.

This 1120 square-foot affordable plan features four bedrooms and a large great room area. The vaulted ceiling over the great room is constructed with 10-inch structural insulated panels, creating a grand central space in the house. A covered porch entry area highlights the street side entrance. The garage is assumed to be detached and located off an alley.

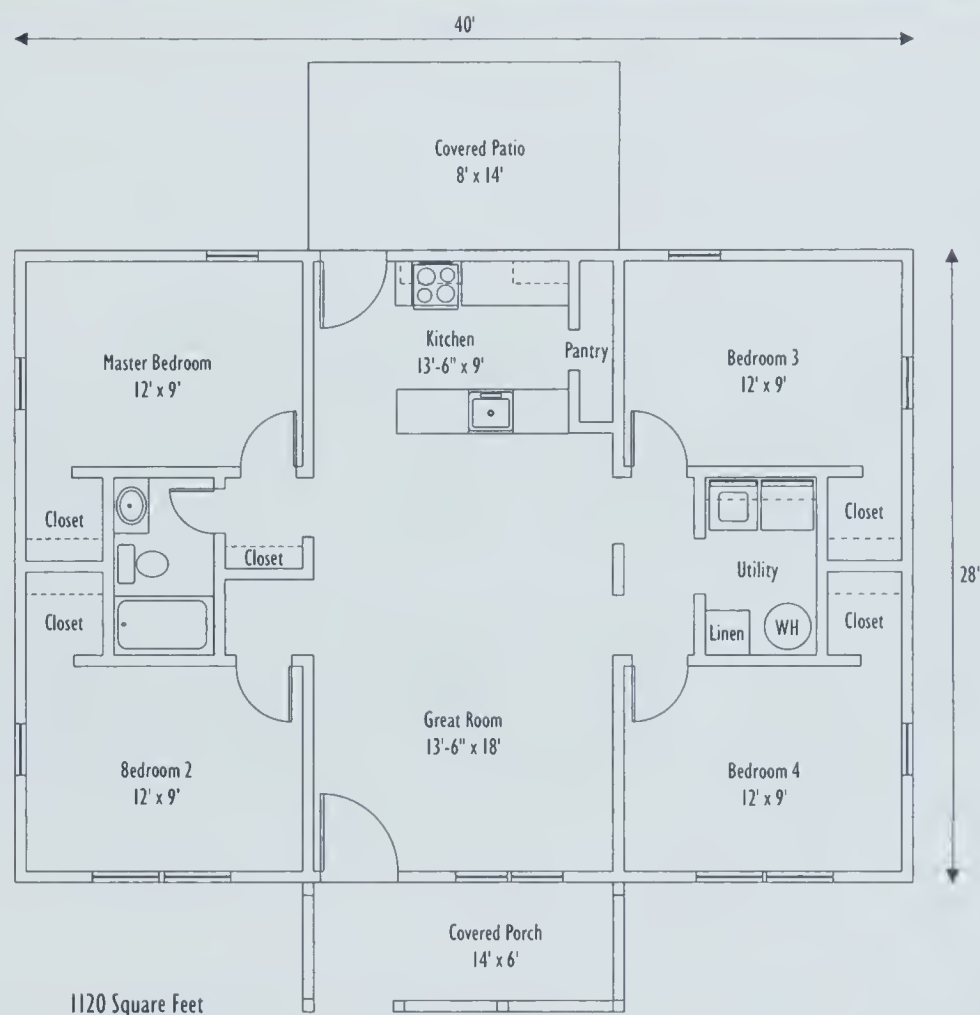
The house has been designed with both energy efficiency and resource efficiency in mind. A frost-protected shallow foundation design and one inch of underslab insulation work together to lower construction costs and increase energy efficiency. The home also has a



PLAN CODE: PLAN 11
DESIGNER: HIGH PLAINS ARCHITECTS, P.C.
SQUARE FOOTAGE: 1120
BEDROOMS: 4
SIZE: 28 FT. X 40 FT.

radiant floor heating system. Walls are constructed with six-inch structural insulated panels. Structural insulated panels are stronger than conventional stick framing and perform better thermally. The ceiling is insulated with blown-in cellulose to R-42.

Windows are placed to maximize the potential for passive solar heating, natural lighting, and ventilation.



AFFORDABILITY AND ENERGY FEATURES

FROST-PROTECTED SHALLOW FOUNDATION DESIGN
 UNDERSLAB INSULATION
 RADIANT FLOOR HEATING SYSTEM
 WALLS AND CEILING HIGHLY INSULATED
 WINDOWS PLACED TO MAXIMIZE POTENTIAL FOR PASSIVE SOLAR HEATING



PLAN CODE: PLAN 12
DESIGNER: HIGH PLAINS ARCHITECTS, P.C.
SQUARE FOOTAGE: 1280
BEDROOMS: 4
SIZE: 20 FT. X 32 FT.

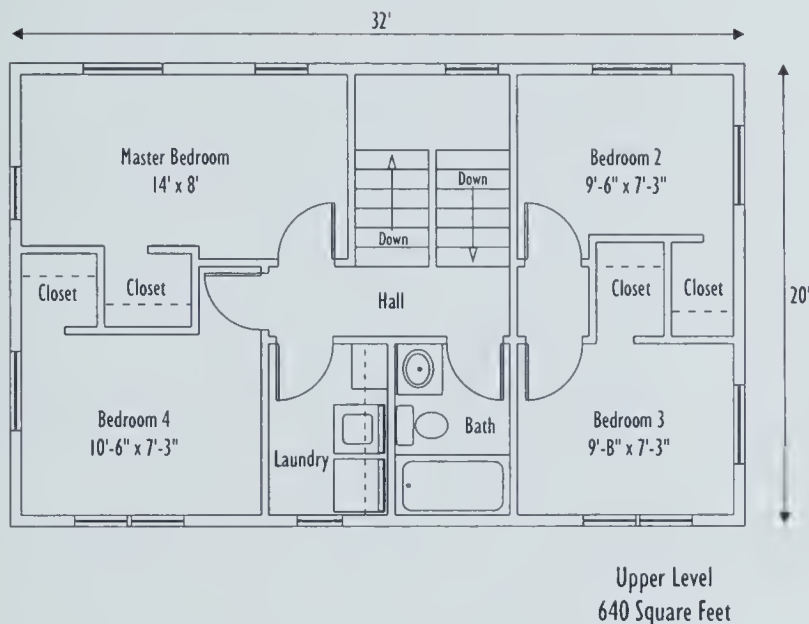
PLAN 12

BEARTOOTH

This 1280 square-foot house features four bedrooms on the second level and a large great room on the main level. The laundry room is located on the second level. The main level ceilings are nine feet high, creating a spacious feeling. A covered porch entry area highlights the street side entrance. This plan is shown with an attached one-car garage on the west side of the house. The garage could also be detached and located off an alley.

The house has been designed with both energy efficiency and resource efficiency in mind. The plan is laid out on a two-foot module to maximize the use of standard construction materials. A frost-protected shallow foundation design and one inch of underslab insulation work together to lower construction costs and increase energy efficiency.

The home also has a radiant floor heating system. Walls are constructed with six-inch structural insulated panels. Structural insulated



panels are stronger than conventional stick framing and perform better thermally. The ceiling is insulated with blown-in cellulose to R-42. Windows are placed to maximize the potential for passive solar heating, natural lighting, and ventilation.

PLAN 13

BRIDGER

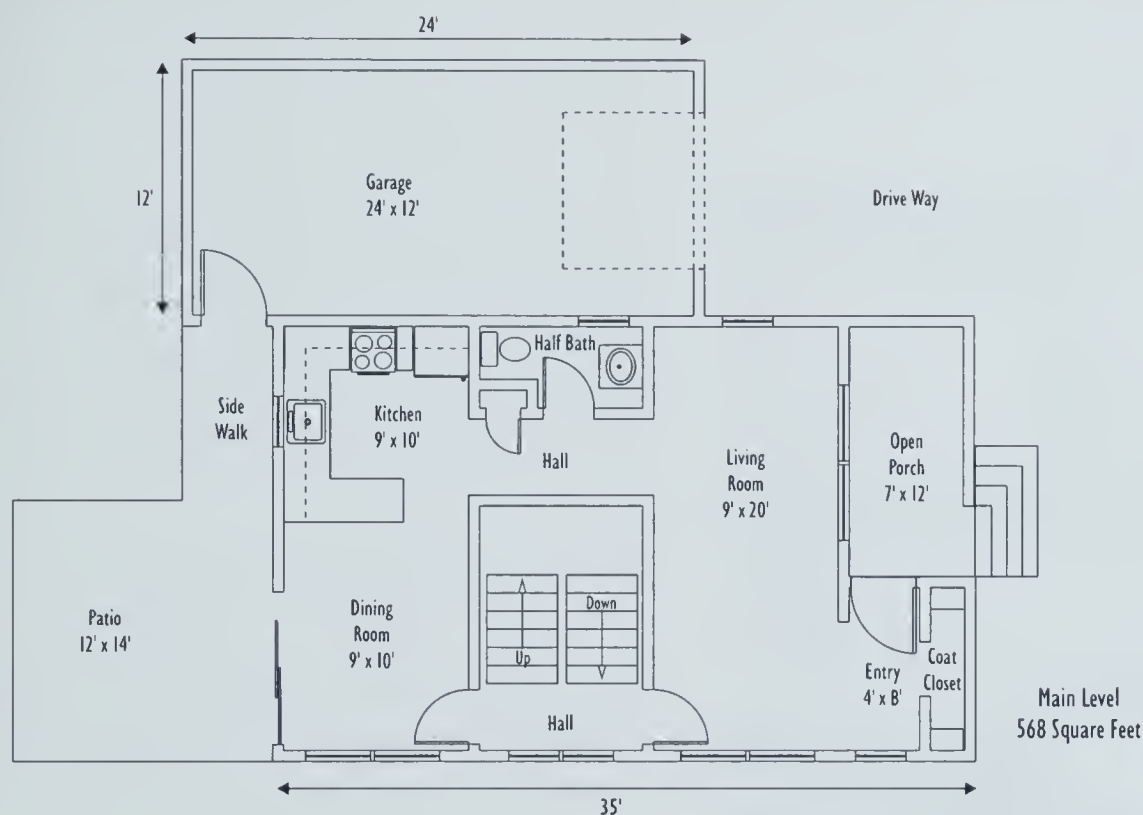


PLAN CODE: PLAN 13
DESIGNER: HIGH PLAINS ARCHITECTS, P.C.
SQUARE FOOTAGE: 1080
BEDROOMS: 2
SIZE: 20 FT. X 35 FT.

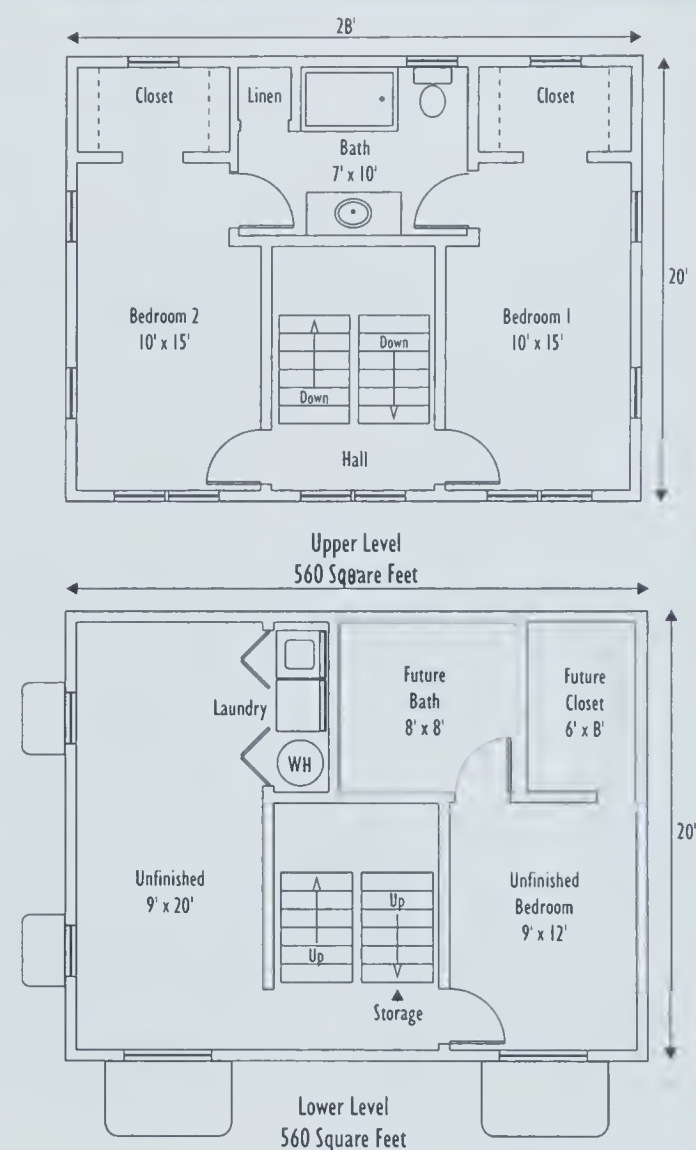
This house has been designed for a small urban lot or a rural site. The ideal building site should be flat and allow passive solar orientation along the south axis of the house. The house is oriented with the entry façade facing east. The plan could easily be mirrored to allow the entry façade to be on the west side of the house. The unfinished basement area can be roughed-in to allow for a future bathroom, family room and small bedroom or home office area. The main level ceilings are nine-foot high, creating a spacious feeling.

An attached garage is shown on the north side of the house. The garage has been designed to be expanded into a two-car garage if needed. Alternatively, the garage can be detached and located off an alley.

The house has been designed with both energy efficiency and resource efficiency in mind. The house is constructed with an R-10 insulated foundation, six-inch structural insulated panels, R-42 blown-in cellulose in



the ceiling, and low-e windows. Structural insulated panels are stronger than conventional stick framing and perform better thermally. Windows are placed to maximize the potential for passive solar heating, natural lighting, and ventilation. Windows are also sized according to their orientation. Thus the majority of windows face south and smaller window sizes are used on the north, east, and west side elevations.



AFFORDABILITY AND ENERGY FEATURES

INSULATED FOUNDATION
WALLS AND CEILING HEAVILY INSULATED
LOW-E WINDOWS POSITIONED TO MAXIMIZE PASSIVE SOLAR HEATING

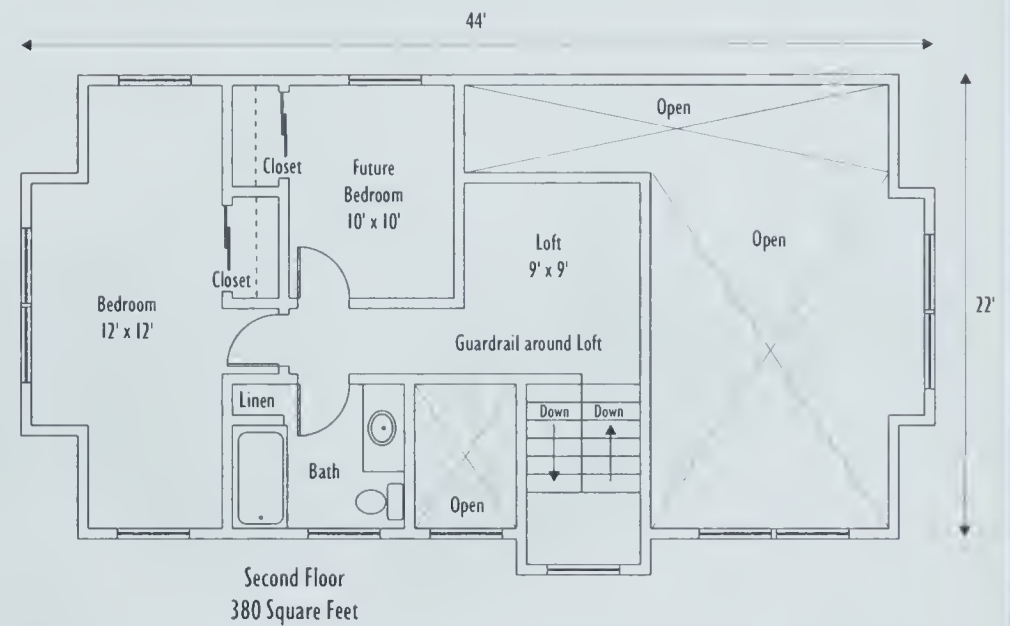
PLAN 14

The inspiration for this design comes from a rural Montana setting, and incorporates many features that were prominent with regional homes a century ago. A large front porch provides a space to gather with friends. Exposed eave details are derived from the simple construction of the craftsman bungalow.

The compact size and straightforward layout of this house results in an affordable house of high quality. Although inexpensive, this house is one to take pride in. The loft and open kitchen plan work to create a living area that feels large, although the individual spaces are quite small. The floorplan consists of three bedrooms, two baths and features a two-story entry and living space with an open loft. This plan can be easily adapted to allow for an attached or detached garage.



PLAN CODE: PLAN 14
DESIGNER: SANDHOLM ARCHITECTS
SQUARE FOOTAGE: 1300
BEDROOMS: 3
SIZE: 22 FT. X 44 FT.



AFFORDABILITY AND ENERGY FEATURES

COMPACT SIZE AND STRAIGHTFORWARD LAYOUT
 HIGH-PERFORMANCE WINDOW GLAZING REDUCES HEAT LOSS
 HIGH-R INSULATED CRAWL SPACE



PLAN 15

This home is well suited to a narrow in-town lot fronting on a north-south street with an alley behind. The entry may be approached from both the street and alley side. The long glazed sidewall should always be faced south for proper orientation. The open plan provides a visually expansive living and dining area that flows out onto a south-facing terrace or garden. The two bedrooms are separated for privacy, making this compact house ideally suited for shared adult occupancy or families with an older child or two.

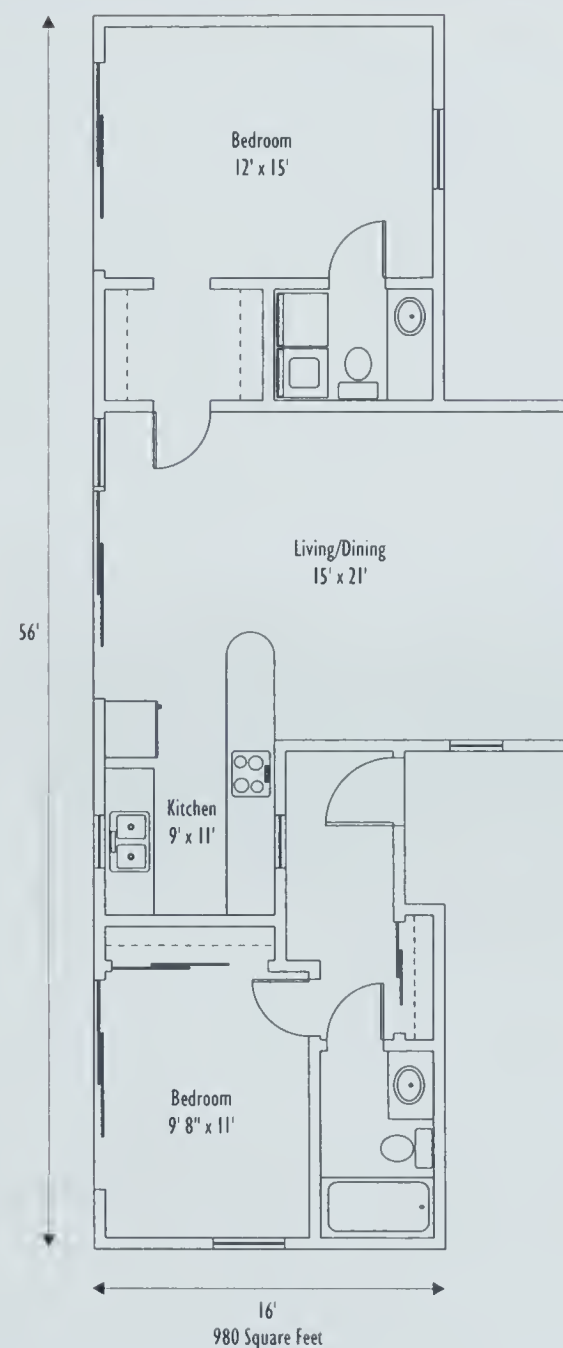
The efficiency of the plan creates a sense of spaciousness without adding unnecessary expense. The straightforward footprint simplifies both foundation and roof construction. Utility and life-cycle costs are minimized with this design, as well as first cost. The house is designed to take full advantage of standard building materials and utilizes advance framing techniques to reduce costs. The simple short-span design is readily adaptable to using either steel framing materials or structural insulated panel construction.

PLAN CODE: PLAN 15
 DESIGNER: FERDINAND S. JOHNS, ARCHITECT, AIA
 SQUARE FOOTAGE: 980
 BEDROOMS: 2
 SIZE: 16 FT. X 56 FT.

The simple plan faces all principal rooms to the south, the optimum orientation for maximizing passive solar gains. Overhangs on this façade allow deep winter sun penetration, but no direct gains during the summer months. Additional smaller windows or doors open to the north, west, and east to admit natural light and induce summer cross ventilation in all rooms. The insulated concrete floor slab is chemically stained and waxed to provide a durable finished floor material and passive solar heat storage. This design suggests that a reasonable degree of amenity can be achieved with an economy of means in an energy-efficient house.

AFFORDABILITY AND ENERGY FEATURES

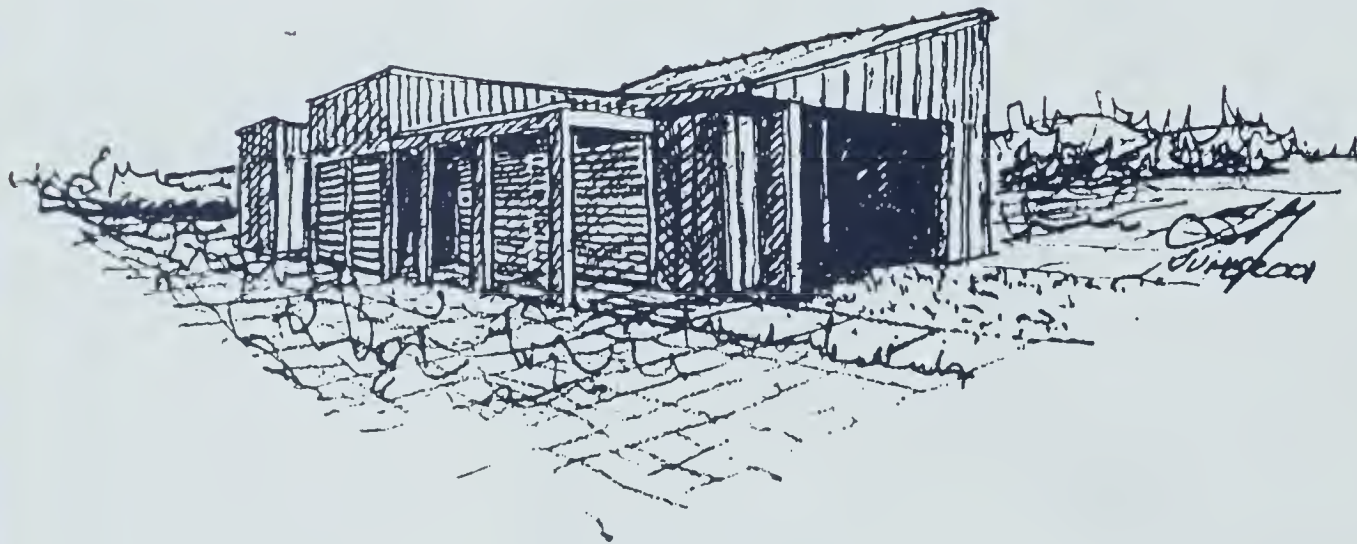
INSULATED SLAB FLOOR
 PASSIVE SOLAR GAINS
 FROST-PROTECTED SHALLOW FOUNDATION
 WALLS AND CEILINGS HEAVILY INSULATED



PLAN 16

This house is well suited to level in-town lots which can benefit from the privacy offered by a courtyard house. It can provide proper solar orientation and privacy on nearly any level lot of adequate width and depth. The living and dining areas expand both visually and physically out onto a south-facing terrace. The glazed façade of the bedroom wing may be oriented either east or west as dictated by climate or site conditions by simply reversing the plan. Bedrooms are adequately sized and designed to accommodate a variety of living arrangements ranging from a young family to a retired couple. An optional carport or garage can serve to define the entry and is conveniently linked to the rest of the house.

The efficiency of the plan and sections create a sense of spaciousness without adding unnecessary expense. The house is designed to take advantage of standard building dimensions to reduce construction costs. Advanced or optimum value engineering framing techniques are used to reduce waste and increase energy efficiency. The simple, short-span



PLAN CODE: PLAN 16
DESIGNER: FERDINAND S. JOHNS, ARCHITECT, AIA
SQUARE FOOTAGE: 992
BEDROOMS: 2
SIZE: 16 FT. X 40 FT.

design is readily adaptable to using either steel framing materials or structural insulated panel construction. Materials are durable yet inexpensive and readily available.

The primary glazed façade can face south, the optimum orientation for maximizing passive solar gain. The overhang on the south side allows deep winter sun penetration, but admits no direct solar sun in the summer. Smaller windows are placed to provide natural light and cross ventilation throughout the house. The insulated concrete floor slab is chemically stained and waxed to provide a durable finished floor material and passive solar heat storage.

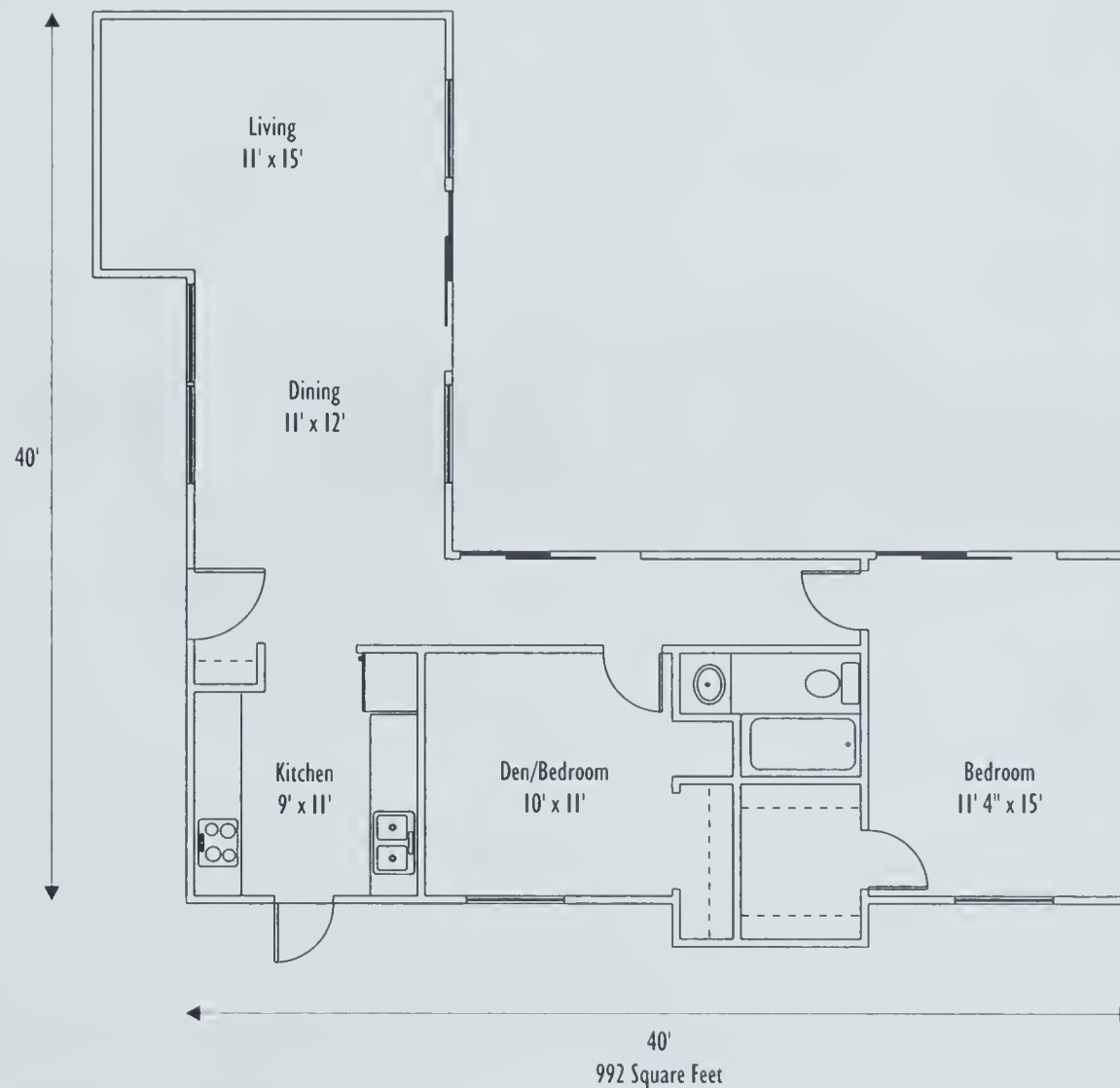
AFFORDABILITY AND ENERGY FEATURES

INSULATED SLAB FLOOR

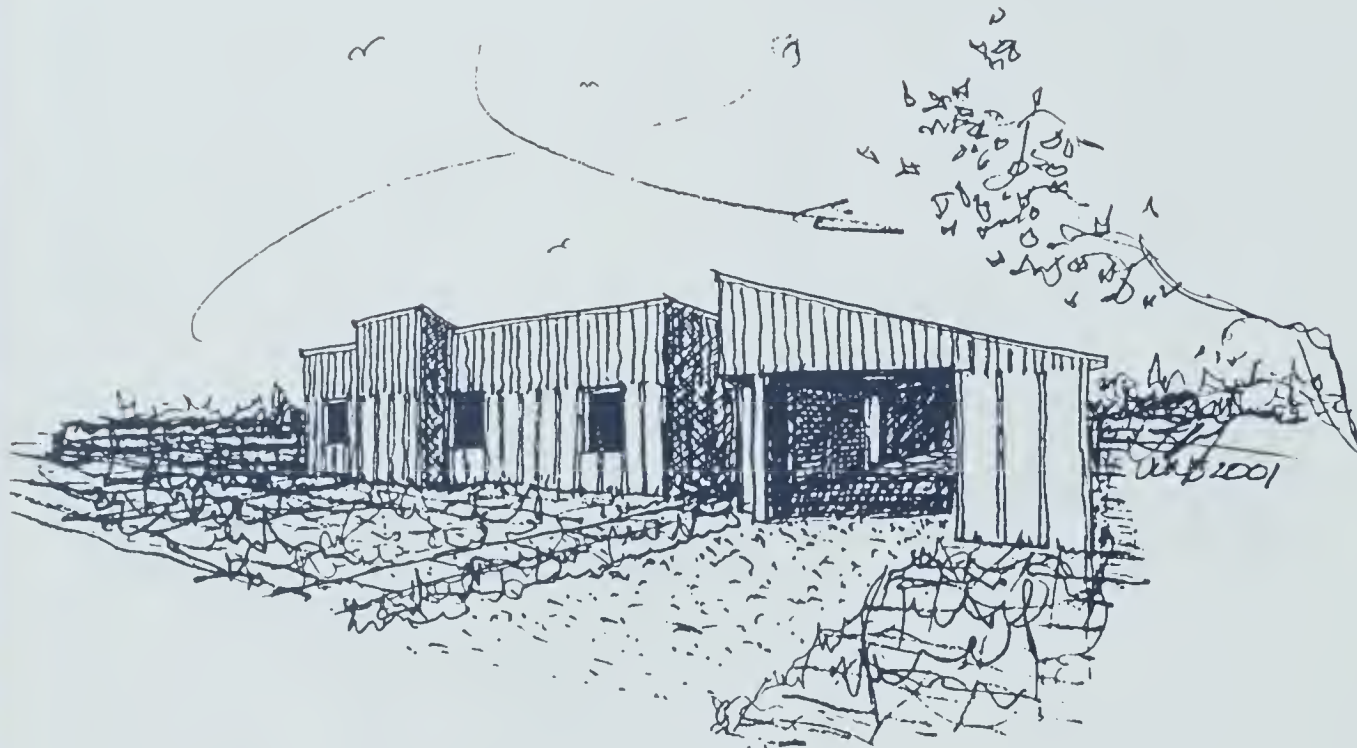
PASSIVE SOLAR GAINS

FROST-PROTECTED SHALLOW FOUNDATION

WALLS AND CEILINGS HEAVILY INSULATED



PLAN 17



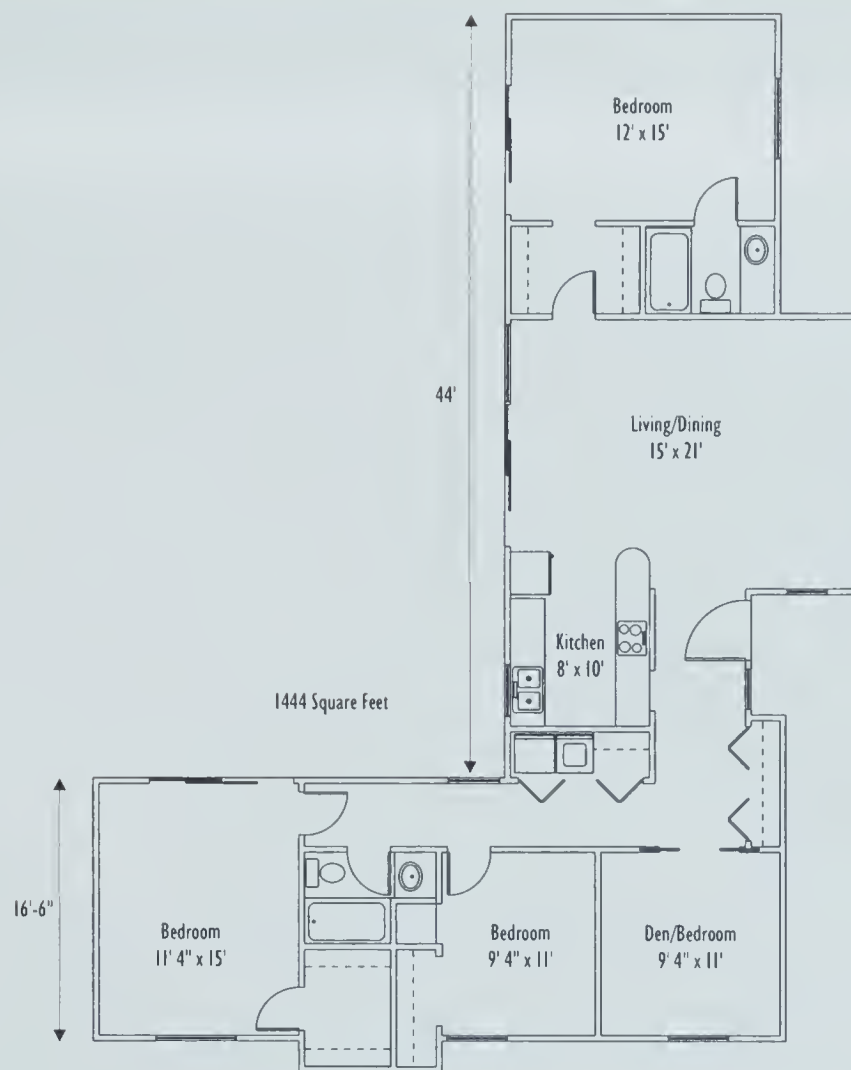
PLAN CODE: PLAN 17
DESIGNER: FERDINAND S. JOHNS, ARCHITECT, AIA
SQUARE FOOTAGE: 1444
BEDROOMS: 4
SIZE: 16 FT. X 42 FT.

This house is well suited to level in-town lots that can benefit from the privacy offered by a courtyard house. It can provide proper solar orientation and privacy on nearly any level lot of adequate lot width and depth. The living and dining areas expand both visually and physically out onto a south-facing terrace. The glazed façade of the bedroom wing may be oriented either east or west, as dictated by climate or site considerations, by simply reversing the plan. One of the smaller bedrooms can be configured as a den opening onto the gallery. All bedrooms are adequately sized and designed to accommodate a wide variety of living arrangements. An optional carport or garage serves to define the entry, but may alternatively be located to partially enclose and screen the courtyard.

The efficiency of the plan creates a sense of spaciousness without adding unnecessary expense. The relatively simple roof and modular plan form a contained south-facing courtyard that allows a less expensive smaller lot to achieve a sense of privacy and amenity.

Utility and life-cycle costs are minimized with this design, as well as first cost. The house is designed to take full advantage of standard building materials and utilizes advance-framing techniques to reduce costs. The simple short-span design is readily adaptable to using either steel framing materials or structural insulated panel construction.

The simple plan faces all principal rooms to the south, the optimum orientation for maximizing passive solar gains. Overhangs on this façade allow deep winter sun penetration, but no direct gains during the summer months. Additional smaller windows or doors open to the north, west, and east to admit natural light and induce summer cross ventilation in all rooms. The insulated concrete floor slab is chemically stained and waxed to provide a durable finished floor material and passive solar heat storage.



AFFORDABILITY AND ENERGY FEATURES

INSULATED SLAB FLOOR
 PASSIVE SOLAR GAINS
 FROST-PROTECTED SHALLOW FOUNDATION
 WALLS AND CEILINGS HEAVILY INSULATED



ENERGY

BUILDING A HOME WITH COMFORT AND EFFICIENCY IN MIND

It makes sense to include energy-efficient features in a house as it is built, rather than renovating later. Key features such as high performance windows, high efficiency heating systems, extra insulation, and proper air sealing are much cheaper and easier to build into a new house than to add to an existing one. Montana state income tax credits will also help to lower your first costs when you build a home that is above the minimum required construction code.

Saving money on your taxes is nice, but most people feel the increased comfort alone is a good reason to build an energy-efficient house. Energy-efficient houses are draft-free, resulting in uniform temperatures throughout rooms, even next to outside walls and windows. Rooms also are generally quieter, because thicker walls, better windows, and more insulation shield the house from outside noise.

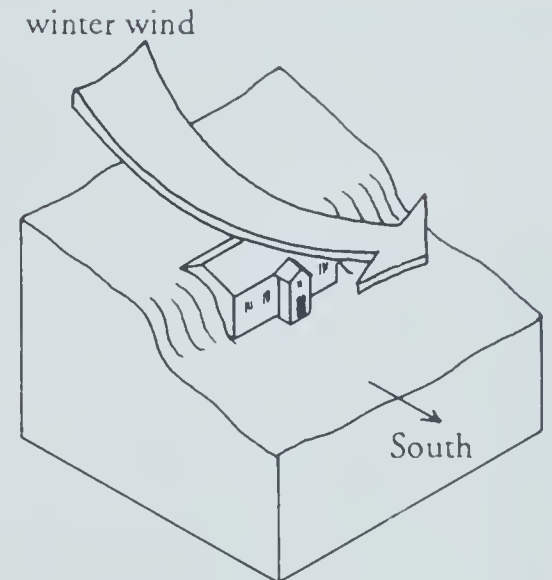
Lower space heating requirements over

the life of the house saves you money each month and helps protect the homeowner against increases in the cost of energy. A house designed properly with south-facing windows can gain a sizeable portion of space heat from solar energy.

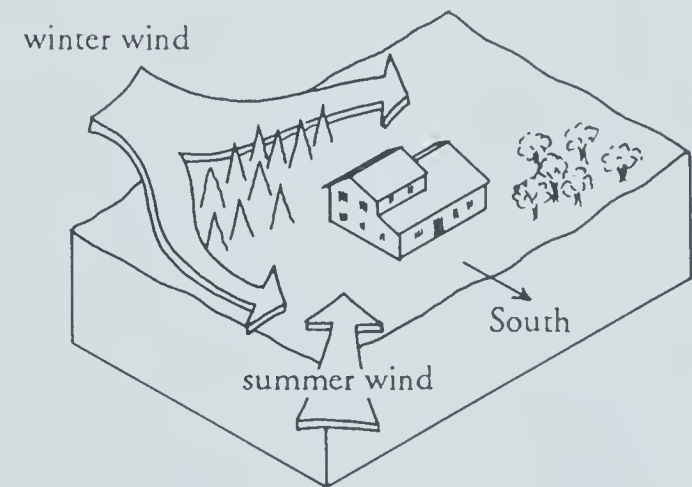
CHOOSING THE BUILDING SITE

The best site plan takes advantage of natural features, such as a south-facing slope. If the north side of a house can be sunk below ground surface on a south-facing slope, less surface area is exposed to the wintry blasts from the north, and the south side is still accessible to the warming rays and natural lighting from the low winter sun. A good view to the north needn't be sacrificed, however. Thoughtful window selection and placement can minimize the disadvantages of north windows.

Benefits of a well-sited house extend beyond reducing the need for auxiliary heat and light in the house. If the yard surrounding the house is well protected, entries are more comfortable to use, outdoor play spaces are usable on sunny winter days, and outdoor use



Earth Shelter



Landscaping



Orientation

FOR OPTIMUM HEAT COLLECTION, SOUTH WINDOWS MUST HAVE FULL ACCESS TO THE SUN ON WINTER DAYS WITHOUT THE INTERFERENCE OF TREES OR BUILDINGS. THE SUN'S ANGLE DETERMINES THE MAXIMUM HEIGHT OF TREES OR BUILDINGS ON THE SOUTH SIDE OF A HOUSE. ON DECEMBER 21 AT NOON, THE SUN'S ANGLE WILL BE $18\frac{1}{2}$ DEGREES ABOVE THE HORIZON AT HAVRE AND INCREASE AS ONE MOVES SOUTH—TO 22 DEGREES AT WEST YELLOWSTONE, FOR EXAMPLE.

areas such as patios can be comfortably used from spring through fall.

Vegetation and soil berms can be used to protect a house from the weather. A windbreak of closely-spaced evergreens placed at a distance of one to two house heights upwind will help protect the dwelling from wind. Shading the house with deciduous trees can substantially reduce summer roof and wall temperatures.

SOLAR CONSIDERATIONS

Orientation

A properly oriented and designed house can acquire a significant amount of its' space heat from the sun. Sun entering through the windows heats up the interior surfaces and furnishings, which helps keep the space warm after sundown, reducing the time that the heating system must operate.

Placing the house on an east-west axis exposes the south side to maximum heat gain in the winter. In Montana, the long side of a house can face as much as 30 degrees east or west of true south (not magnetic compass

south) and still receive over 90 percent of the available solar energy. Orienting south-facing windows to the east of true south means early warming of rooms in the winter. Orienting the windows west of true south results in afternoon warming, which is usually less desirable than morning warming. West-facing windows are subject to overheating all year long because the setting sun is low no matter what the season.

No obstacles should be in the way of the low angle rays of the winter sun from about 9:00 a.m. to 3:00 p.m., when more than 90% of the useable winter solar radiation occurs. If the sun is blocked for even one hour, up to 20 percent of energy will not be available.

Windows

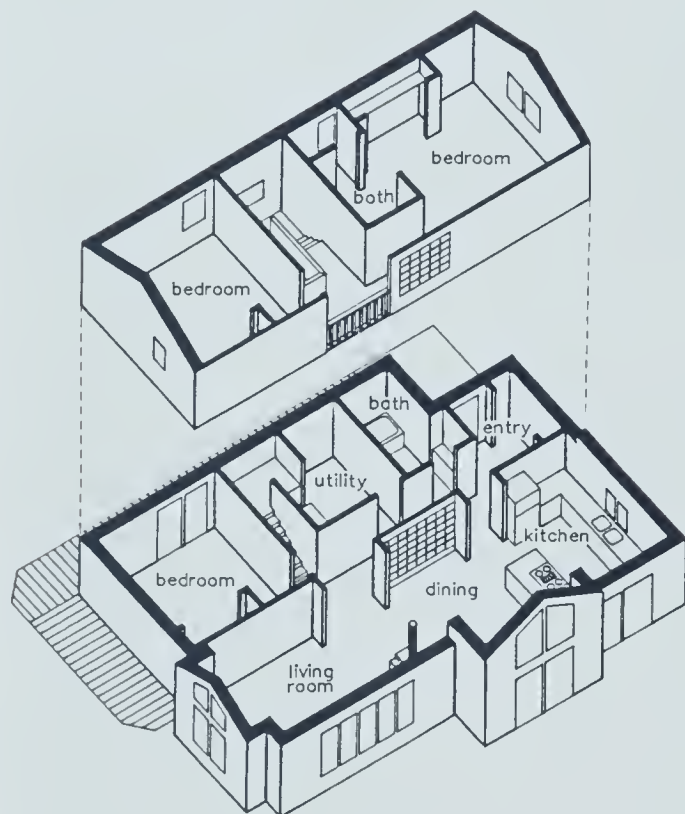
Space devoted to windows should equal 8% to 15% of the total floor area. Of the total glazing, 50% should be placed on southern exposures, 25% on the east, 15% on the west and 10% on the north. North-facing windows have no heat gain and, in fact, cause a great deal of heat loss. Heat loss through windows can be minimized by covering them with insulated window shades at night or installing high-performance windows.

Shading

The installation of most glazing on the south can reduce the total space heating bill, but offers a potential for overheating unless adequate shading and ventilation are provided. An 18- to 24-inch roof overhang will shade south-facing windows from late April to late September at most Montana latitudes. When the sun is lower in the sky, the window becomes less shaded so all available solar energy enters during the heaviest heating season — late October to late February. Where the length of the overhang is restricted, such as on the gable ends of a house, an awning mounted just above a window will provide shade.

Although blinds or draperies stop the sun's rays from striking the interior, much of the heat is already in the building after passing through the glass. Exterior shades are more effective in preventing overheating. Shading can be augmented with deciduous trees or with window coverings. Thought should go into the selection and placement of deciduous trees, some of which can block up to 50 percent of the sun, even without their leaves.





Room Placement

THE INFLUENCE OF DESIGN

A compact shape and simple floor plan contribute to building convenience and construction savings. A streamlined house is much easier to make energy efficient than one with many levels, projections and corners. However, the dormers, cupolas, and cantilevers that create the interesting jogs and roof angles of a house needn't be eliminated if care is taken to ensure that the exposed areas are sealed and insulated.

The design of energy-saving houses considers solar energy, natural light and room relationships. Rooms used often by all family members, such as living or family rooms, should take advantage of natural light and solar heat. Placing these rooms on the south side enables the sun to warm the space during the day. Living areas that will be used primarily in the evening should be located in the southwest part of the house to take advantage of natural evening light. The working areas — utility, bathroom, and garage — require plumbing, more artificial light, and lots of storage. These rooms require few if any

windows and can be placed on the north side. Bedrooms placed on the east side allow for enjoyment of the early morning sun.

Many energy-saving plans have the living spaces open to one another so that passively-heated air is free to move around the space. This usually works better than a house with many separate rooms that restrict movement of heated air to various areas. Houses with forced air heating, however, can use the furnace fan to move air.

Sunspaces should be designed with plenty of ventilation, shading, or thermal storage so they won't overheat.

Recessed or sheltered entries and those facing east or south will avoid letting in the worst winter weather. An airlock entry will also reduce drafts. Placing the garage on the northwest buffers the house from chill winter winds and can create a sheltered entryway or double as a vestibule.

TRAPPING THE HEAT

How Homes Lose Heat

Even poorly-sited houses with little potential for passive solar gain can be energy efficient when the ceiling, walls, foundation, windows,

and doors are thoroughly insulated and sealed. To understand the benefits of proper insulation and sealing, it is necessary to understand how heat is lost in a house. Heat moves from areas of higher temperature to areas of lower temperature. It moves by three methods: conduction, convection, and radiation.

Conduction refers to the movement of heat through a solid object. One example is the conduction of heat from a stove burner through an iron skillet. Another example is heat traveling from a house's warm interior through studs in the exterior wall to the outdoors.

Convection refers to the movement of heat through a fluid such as air or water. Wind blowing against a warm window and carrying heat away is an example of convective heat loss.

Radiation describes the transfer of heat from a warm object to a separate cooler object, but without affecting the temperature of the air. An example is a bonfire radiating heat to those standing nearby. Another example is radiation from warm household furnishings to cooler window panes.

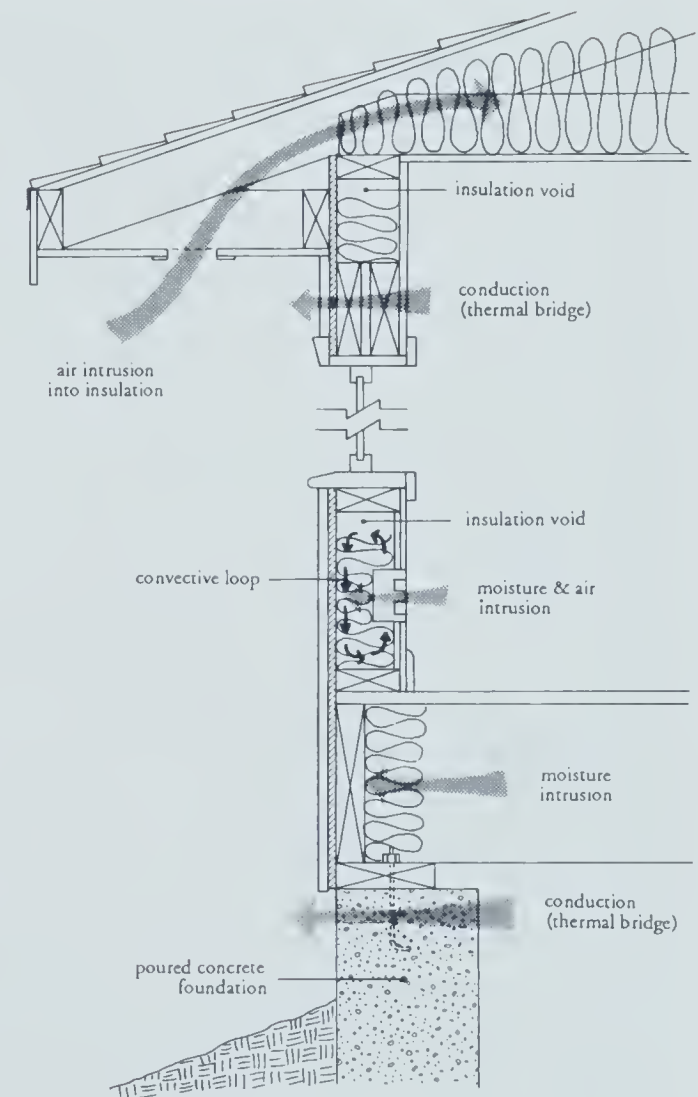
These three methods of heat loss work in concert. For example, heat radiates from

warmer furnishings to cooler outside walls or windows. From there it travels by conduction through the wall studs or window glass and frame to the exterior. Upon reaching the house's exterior, heat both radiates to cooler outside objects and dissipates through convection in the outside air. Convection heat also travels from a house's warm interior to the cooler outside through cracks where building components join and through openings where plumbing or electrical service enter the house.

Insulation

Exterior walls, ceilings, and floors are kept warm by high levels of insulation, which reduce radiant heat loss and heat conduction through the building components. For an insulation system to be fully effective, it must be installed to eliminate gaps, thermal bridging, air intrusion into the insulation (common in attics), and moisture condensing in the wall cavity and wetting the insulation.

The amount of insulation required depends on the house's location and the price of fuel or electricity used in heating. Recommended insulation levels are shown in the table below. R-value refers to a materials ability to stop heat from passing through it; the higher the R-



Thermal Defects

Recommended Insulation and Efficiency Levels

Component	Model Energy Code minimum home	More Efficient Home
Ceiling R-value	Standard Truss R-38	Energy Truss R-50
Walls Above Grade	Standard Framing R-19	Advanced Framing R-21 – R-26
Finished Basement Walls	Standard Framing R-10	Advanced Framing R-15 – R-19
Crawlspace	R-19	R-25
Slab-On-Grade	R-10 Perimeter	R-15
Window U-value	U - .40	U - .35 or less
Gas Furnace Efficiency AFUE	Standard Efficiency AFUE 78%	High Efficiency Furnace AFUE 90% or higher

Many homes built today only build to the Model Energy Code minimum levels. These insulation levels are the minimum level allowed and should not be considered the optimum insulating level for a home. Upgrading insulation levels above the minimums makes a great deal of sense for a new construction project. Homeowners who build above code can also take advantage of a \$500 Montana energy conservation tax credit to lower the net costs of their investment in energy efficiency.

value, the better the insulation resists heat loss. Window energy performance is often expressed in terms of U-value. The lower the U-value, the less energy or heat is lost through the window. AFUE refers to the annual fuel utilization efficiency or overall performance of a heating system.

WINDOWS

Although windows are desirable for passive solar heating, ventilation, natural lighting, and viewing, they also are significant heat losers. In Montana, 25% or more of the total heat loss in a house is lost through windows. Improving window energy performance translates directly into lower heating costs for homes. Windows selected for houses will likely remain in the house for 20 – 30 years or more, so windows should be selected with care.

High-Performance Window Benefits
Technology advances in the last 15 years have greatly increased the overall energy performance and comfort of windows today. Advances in new window frame materials, low-e glass coatings, argon gas fills, and warm edge spacers work together to create a high-perfor-

mance window. High-performance windows have a U-value .35 or less. High-performance skylights products have a U-value of .45 or less.

Improved Comfort

Houses in winter with single or double-pane glass often feel drafty and cold when you are standing near the windows. The colder surface temperature of the glass causes us to radiate more heat from our bodies and thus we feel colder also. High-performance windows have surface temperatures on the glass that are much warmer than conventional windows. The increase in glass surface temperature results in improved comfort. Newer windows today also have better weatherstripping that provides a tight seal to reduce air leakage and improve comfort.

Condensation Problems

In Montana, condensation problems with windows during winter are well known to many homeowners. Excessive condensation can even cause mold growth and stain wood windows. These condensation problems can be reduced or eliminated with high-performance windows. Improved window spacers and low-e

coatings increase the glass surface temperature around the edges of the window reducing condensation problems.

Energy Savings

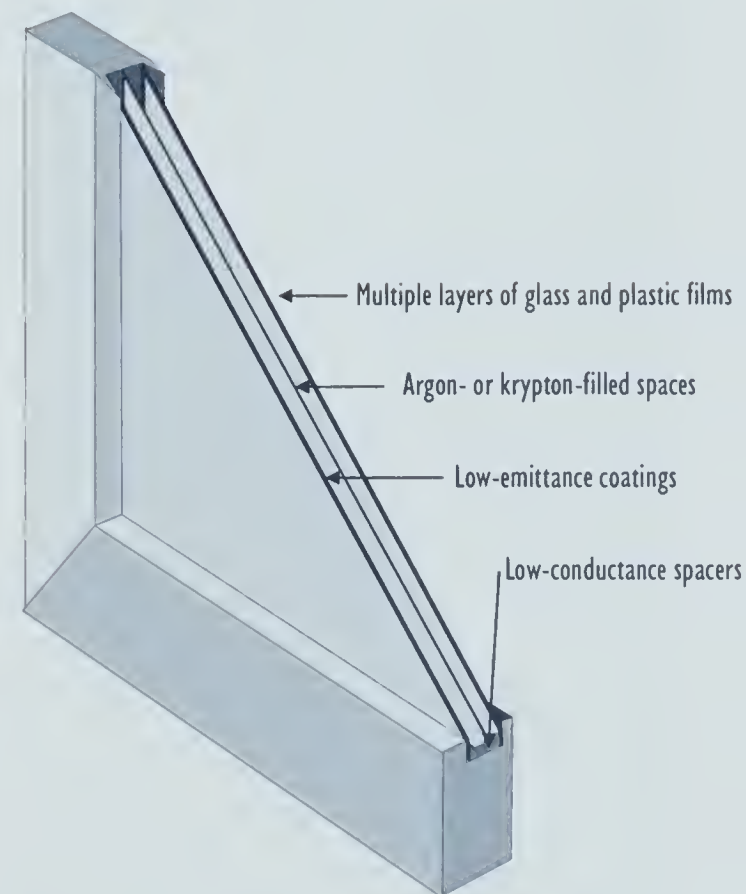
High-performance windows today have much lower heat loss rates and air leakage rates than windows available a decade ago. These improvements result in lower heating bills today and help to lessen the impact of rising utility costs in the future. Selecting the very best high-performance windows may even allow for a reduction in the size and cost of the heating system.

Fabric Fading

Ultraviolet rays from the sun can easily fade furniture fabrics and carpet. Low-e glass used in high-performance windows can reduce up to 75 percent of these harmful rays and prolong the lifetime of your fabrics.

High-Performance Window Features Low-e Coatings

Low-emissivity (Low-e) coatings are the foundation of high-performance windows. A layer of metal oxides-copper, tin, or silver oxide is commonly used, is applied either to



High-Performance Window Components



Money Isn't All You're Saving Selecting High-Performance Windows

Shopping for high-performance window products is easy when you look for the Energy Star logo. The Energy Star program, developed by the Department of Energy (DOE) and the Environmental Protection Agency (EPA), has developed criteria for Energy Star window products. In the northern part of U.S. Energy Star windows are required to have a U-value equal to .35 or less. Skylight products need a U-value of .45 or less. To find Energy Star window products or manufacturers, visit the Energy Star web pages at www.energystar.gov.

the air space side of the inner window pane in double glazing or to a thin layer of polyester film suspended between panes. The Low-e layer reflects heat radiation before it can pass through the window. This effect keeps more heat energy inside during the winter in heating dominated climates. In southern climates, where cooling loads are more dominant, Low-e windows are designed to reject solar heat gains. By reflecting heat into a room instead of letting it pass out, Low-e coatings keep the interior surface of the window warmer than double pane windows without Low-e.

Improved Window Spacers

When building double-pane windows, manufacturers commonly use aluminum spacers around the edges between the two glass panes. Unfortunately aluminum spacers conduct heat well and degrade overall window energy performance. To improve performance in this area manufacturers now have started to use materials that are less conductive than aluminum. These improvements can raise the glass temperature 10% around the window edge area.

Stainless steel, which is less conductive to heat flow compared to aluminum, is now

being used as a window spacer material. Another option to improve performance relies on a laminated sealant system that combines a thin metal spacer material and a sealant material together.

Gas Fills

Convection currents in the air between sealed insulated glass panes conduct heat from the inside glass pane to the outside glass pane. One way to improve thermal performance is to reduce the conductance of the air space by filling it with an inert gas such as argon or krypton. These gases are less conductive than air and improve overall window performance by 5% to 10%.

Window Labels

Visit the National Fenestration Rating Council (NFRC) web pages at www.nfrc.org to compare window energy properties and products.

CONTROLLING AIR LEAKAGE

While most people recognize the value of properly insulating a house, the importance of controlling air leakage is not as well understood. The air leakage in a conventionally built house is usually equivalent to the leakage that would result from a single hole about one foot square through an outer wall. On average a conventionally-built house leaks its entire volume of inside air to the outside every two to three hours. A conventional house may leak air through exterior walls, basement, windows, ceilings, chimneys, and furnace vents. Some houses that are sealed poorly have even higher leakage rates. This excess air leakage or infiltration of cold outside air leads to higher heating bills and comfort complaints.

Air-vapor barrier

An air-vapor barrier prevents the movement of air and water vapor through exterior walls and ceilings. This barrier can be a single component such as a plastic membrane, or a combination of materials such as drywall, gasketing, and vapor barrier paint, installed and joined to block movement of air and moisture.



National Fenestration
Rating Council

CERTIFIED

World's Best Window Co.

Millennium 2000+
Vinyl-Clad Wood Frame
Double Glazing • Argon Fill • Low E
Product Type: **Vertical Slider**

ENERGY PERFORMANCE RATINGS

U-Factor (U.S./I-P)

0.34

Solar Heat Gain Coefficient

0.25

ADDITIONAL PERFORMANCE RATINGS

Visible Transmittance

0.41

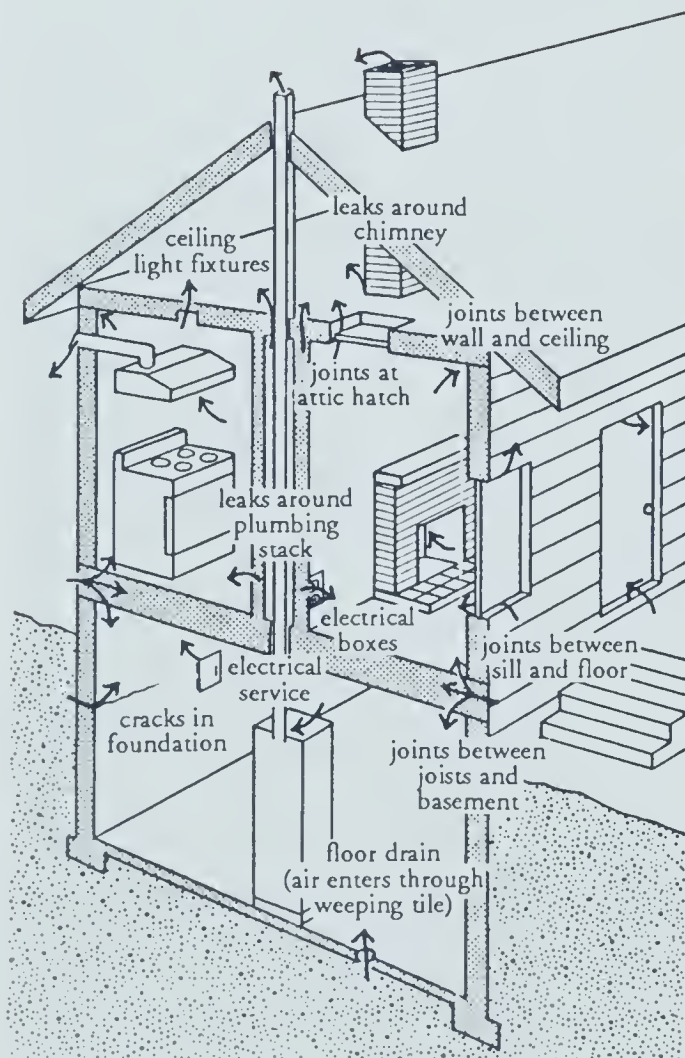
Air Leakage (U.S./I-P)

0.2

Manufacturer stipulates that these ratings conform to applicable NFRC procedures for determining whole product performance. NFRC ratings are determined for a fixed set of environmental conditions and a specific product size. Consult manufacturer's literature for other product performance information.

www.nfrc.org

NFRC Labels Provide Window Energy Performance Data



Air Leakage Sites

Checking for air leaks

Although the barriers to air and vapor are hidden in the finished walls, ceiling, and floors of a house, it is possible to verify their performance. One method is the blower door test, which will tell if and where air leaks occur. These tests are available through specialized weatherization firms and blower door contractors. Evaluation of the house's airtightness readily reveals where improvements are needed.

BUILDING THE ENERGY-EFFICIENT HOUSE

The key to an energy-efficient house is to keep heat in during the winter and let heat out during the summer. This is achieved through a variety of construction methods and the use of appropriate materials and devices.

FOUNDATIONS

Every building must have an adequate foundation to support it. In Montana, most foundations enclose a basement or crawl space, although some houses are built on a floor slab on the ground surface.

Slab Insulation

Insulating under basement slabs is usually not a typical practice in most new home construction. In some cases though it would be wise to consider insulating under the basement slab. Insulating underneath the entire basement slab is recommended for homes with in-floor radiant heating systems. Extruded polystyrene insulation 1 to 2 inches thick is commonly used in these cases. This material has high compressive strength and resists moisture penetration.

Adding insulation can also make sense if you want to improve the comfort of your basement by having a warmer, insulated slab floor. In this case adding 1 inch of extruded polystyrene is recommended.

Basements

One-third of the total heat loss from a house can pass through uninsulated walls and slab. Although soil buffers a foundation from widely fluctuating outside temperatures, it is not a good insulator. Saturated soil in contact with the foundation or slab significantly increases heat loss. This increased heat loss can result even if water is as much as 2 feet below the foundation.

Crawl spaces

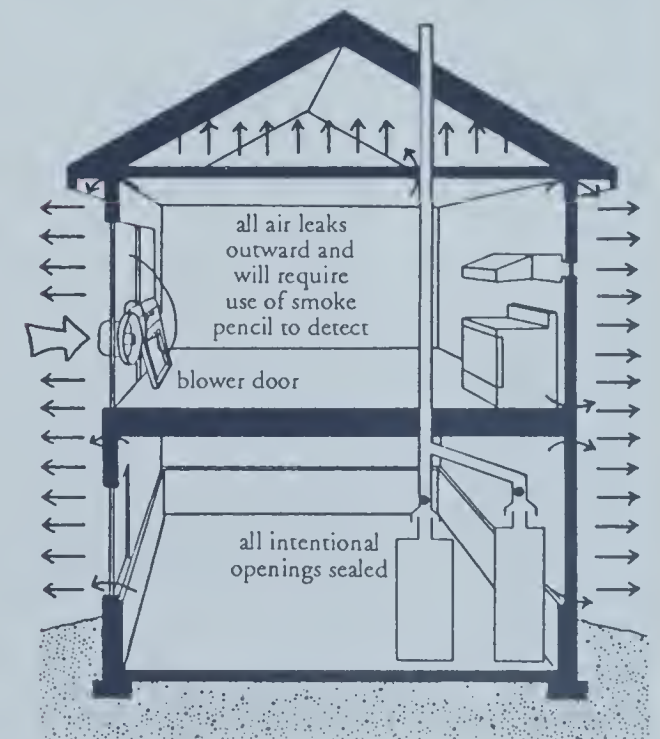
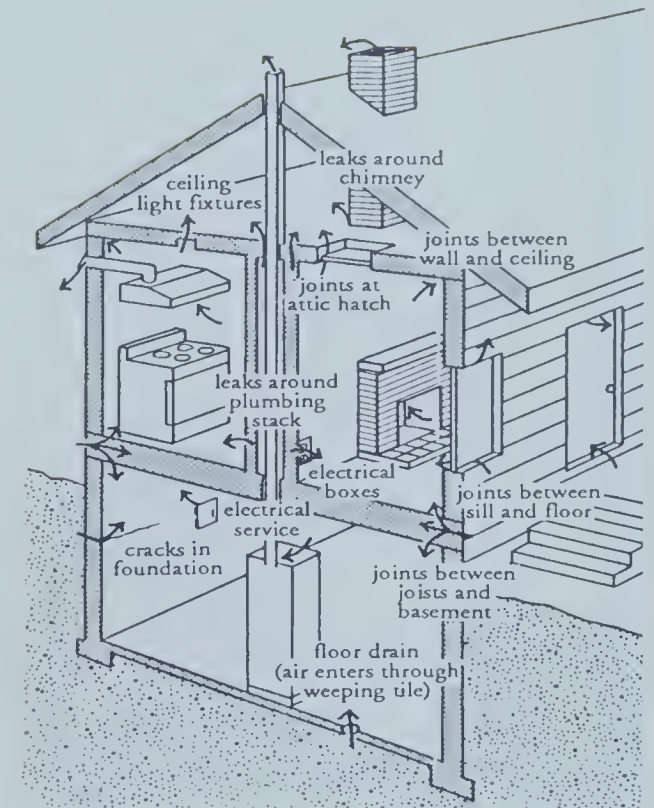
Maximum energy savings and comfort is achieved in crawl spaces by placing fiberglass batts between the floor joists. R19 floor insulation is most common and meets the Model Energy Code minimum standard. Installing R30 floor insulation is better and also qualifies for the Montana energy conservation tax credit. This insulation method reduces the house's heat loss through the floor and allows the crawl space to be ventilated to eliminate moisture-related problems with wet crawl spaces. Heat tape can be wrapped around pipes to prevent them from freezing in ventilated, unheated crawl spaces.

Many people choose to insulate the walls of the crawl space and close the crawl space vents during the heating season. This allows heat from the living space to pass downward through the house floor to warm the crawl space and prevent freezing pipes. It can be cost effective to place insulation both on the crawl space walls and between the floor joists over the crawl space. Placement of R19 insulation in the floor joists and R11 on the crawl space walls is common in Montana. Many builders use R10 rigid foam

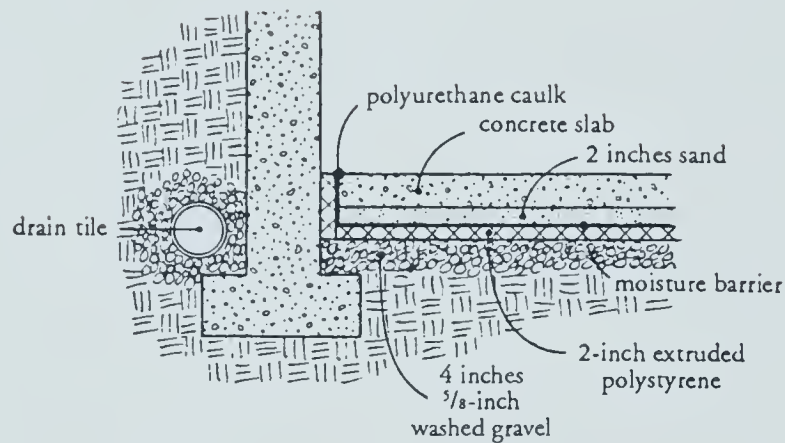
Blower Door Test

A blower door test uses a large variable speed fan mounted in a door to blow air into or draw air out of a house to simulate the effects of pressure differences that cause air infiltration or exfiltration. By artificially exaggerating the pressure difference that occurs naturally between the inside and outside of a house due to wind and temperature differences, the normal air change rate of the house can be estimated.

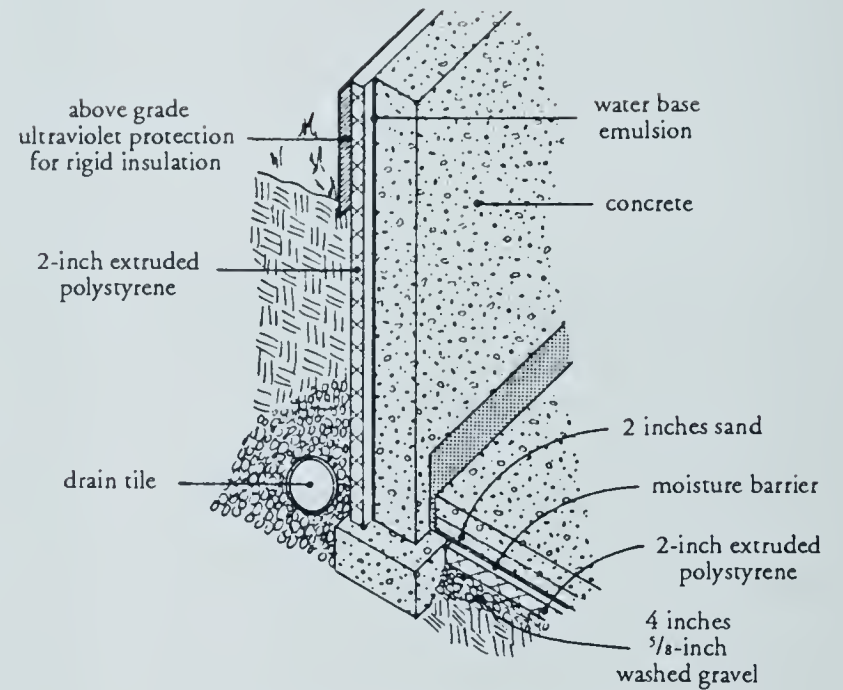
This test also aids in finding air leaks around windows, doors, baseboards, wall and ceiling joints, wall and floor joints, plumbing openings and electrical boxes. While the house is under negative pressure from the fan, a smokestick can be used to track air leakage.



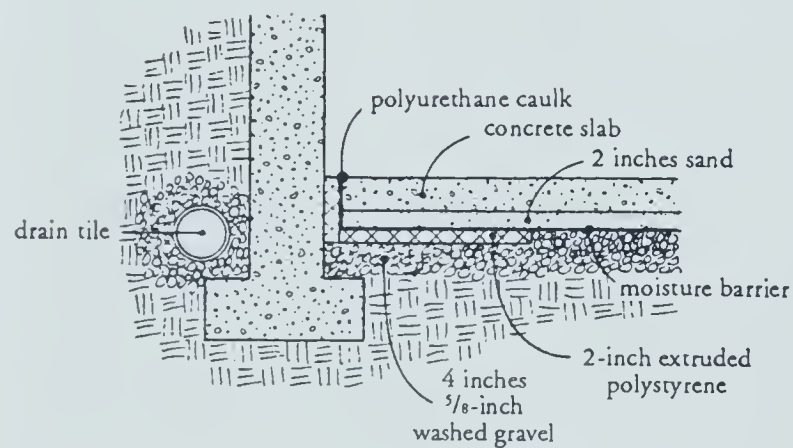
Pressurization Blower Door Test



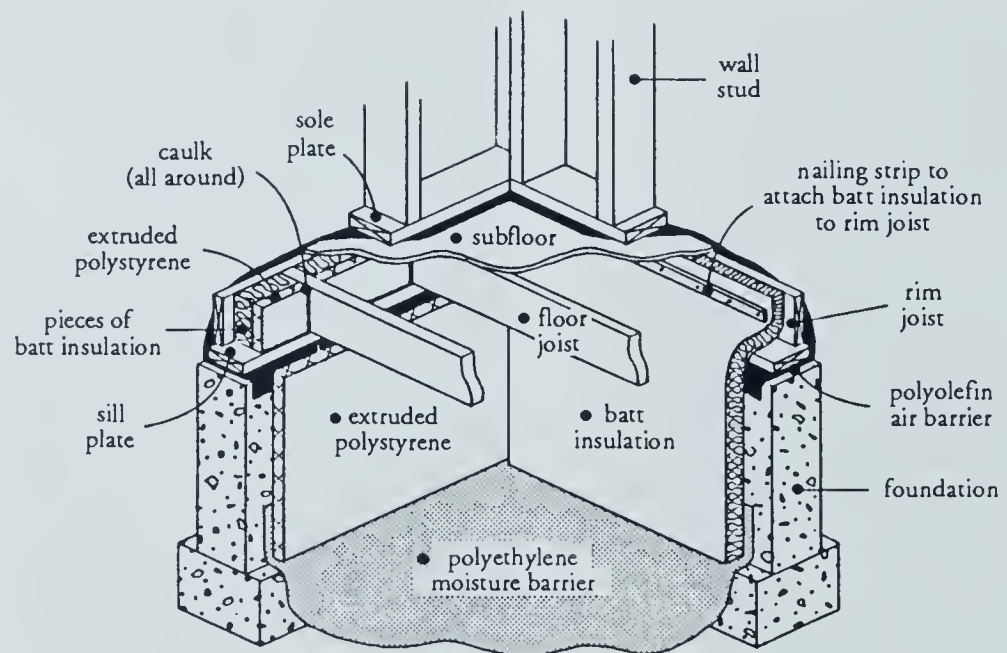
Full Underslab Insulation



Insulation on Exterior Basement Walls



Slab Perimeter Insulation



Typical Insulation in a Crawl Space

board (2-inch extruded polystyrene) on the crawl space walls rather than R11 batts.

A polyethylene moisture barrier is required to prevent the movement of ground moisture into the crawl space. The moisture barrier should be lapped at least 6 inches at all seams. The crawl space vents should be opened in the non-heating months to vent out dampness collected in the crawl space.

Slab-on-grade

A well insulated slab-on-grade floor or frost protected shallow foundation can be an economical floor system for a relatively flat site, especially when the slab can be used to store heat admitted through south-facing windows. With this configuration, linoleum or tile is applied to the concrete as the finished floor surface.

In Montana, the floor slab is typically built as a “floating” slab – one that is inside and separate from the foundation wall. Extruded polystyrene is placed below the slab to control floor heat loss, and applied between the slab and the foundation wall to control heat loss from the edge of the floor slab.

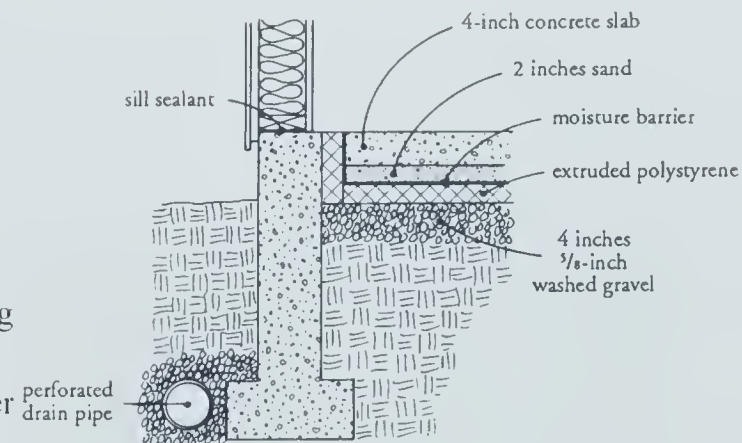
Air-vapor Barriers and Sealants

Air-vapor barriers, sealants, and weatherstripping are used to stop convective heat loss. Polyethylene sheets are the most common air-vapor barrier materials used in new construction. Rigid foam board used on the interior side of the wall can also serve as an air-vapor barrier when the seams are taped.

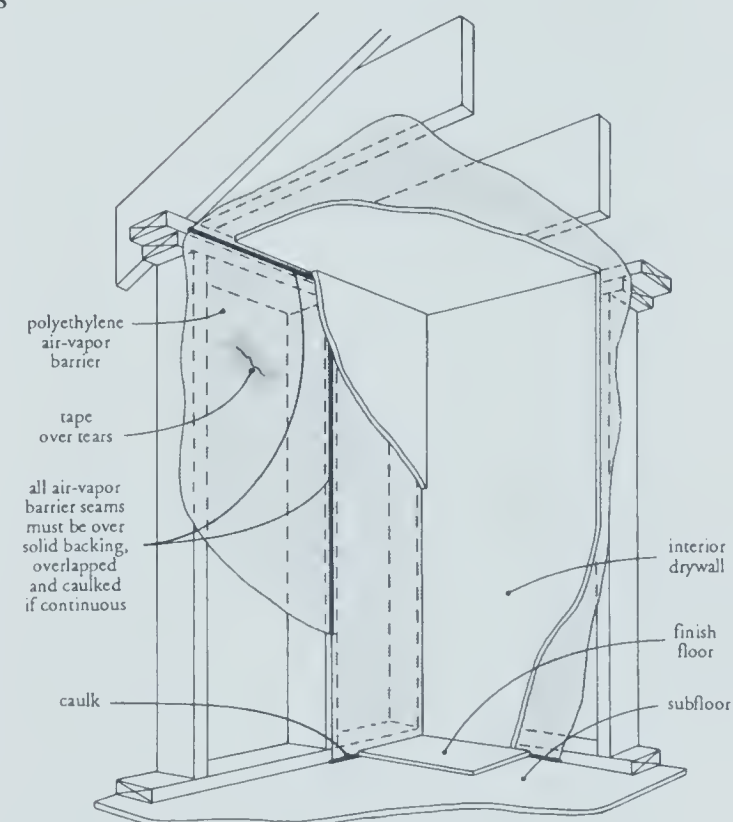
A complete, well-sealed air-vapor barrier is difficult to install because of light fixtures and electrical outlets, plumbing vents and pipes, and other wall penetrations. The obvious first step is to prevent unnecessary holes in the barrier.

A variety of sealants are used to close openings where building components meet. Caulking compounds are used to fill in small cracks. Expanding foam is used for large uneven openings such as around window and door frames, plumbing, and electrical openings that caulking compounds cannot fill. Gasketing materials are used to stop air leakage between the foundation and sill, sill and rim joist, rim joist and plywood subfloor and bottom plate, and behind drywall. Tapes can also be used to seal joints in insulated sheathing, wind barriers or polyethylene.

To eliminate electrical wiring penetrations of the ceiling, use wall-mounted fixtures, or lights mounted on the ceiling surface or a track.



Slab-on-grade Insulation



Polyethylene Air-vapor Barrier

Advanced Framing Features

- Studs placed on 24-inch centers
- Insulated headers
- Insulated corners
- Ladder blocking to allow insulation behind partition walls
- Designing with a two-foot framing module to reduce wasted material
- Eliminating headers in non-load bearing walls

Recessed lights in insulated ceilings are difficult to seal because they must be ventilated to the attic for cooling. Surface-mounted “pancake” boxes permit ceiling fixtures with only small holes in the ceiling. An air-tight seal on the electric service entrance requires sealing the opening for the main service conduit and the opening for the wiring into the exterior walls.

Plumbing penetrations in the air-vapor barrier can be minimized by placing plumbing fixtures on the interior walls. Some penetrations such as plumbing stacks are necessary “punctures” in the ceiling and floor of a house, and must be well sealed with expanding foam to stop air leakage.

EXTERIOR WALLS

Advanced Framing

Wood in a house’s exterior walls and ceilings is one avenue of heat loss from the interior. Wood has an R-value of only 1.25 per inch compared to foam or fiberglass with R-values of 3.5 or more per inch. Consequently, where studs displace insulation, the R-value is lower, reducing the overall insulation value of the wall.

To reduce the amount of wood in the structure of a house, and maximize the amount of insulation in the walls and ceiling, a technique known as advanced framing can be used in most building localities. There may be some instances in Montana where potential high wind loads on a house or seismic zone considerations prevent a builder from using all the advanced framing concepts discussed below. Your builder and code official can determine if you might have problems using advanced framing.

Advanced framing started as a method to reduce building construction costs without sacrificing any structural stability needed for the house. The term first used for this building technique was called Optimum Value Engineering (OVE). The concepts incorporated in OVE or advanced framing have been well researched by the building industry. Advanced framing saves not only on lumber and labor costs but also on heating bills as well.

Standard framing with studs placed 16-inch on center results in a wall that is 23 percent wood and 77 percent insulated cavity. Advanced framing with studs placed 24-inch on center yields a wall that is composed of 17 percent wood and 83 percent insulated cavity.

Less wood in the wall means more room for insulation and more energy savings for you.

The most common wall construction method in Montana is 2 x 6 inch stud walls with R19 fiberglass batt insulation. A builder can improve the energy efficiency of this wall type by using R21 high-density fiberglass batts rather than R19 batts. Taking advantage of the Montana energy conservation tax credit reduces the nominal cost increase of this wall construction method.

Wall designs that accommodate high levels of insulation (R27 or more) and also qualify for the tax credit include single stud walls with either interior or exterior rigid foam board or double stud wall construction.

Single stud wall with foam board insulation

Stud walls are commonly built to a single stud thickness and their cavities filled with fiberglass batts or blown-in insulation. Increasing the insulation by installing 1-inch rigid foam board over the studs achieves an R-value above the Model Energy Code minimum R19 standard and prevents conduction of heat through the studs. Foam board insulation can be placed on the interior or exterior surface of

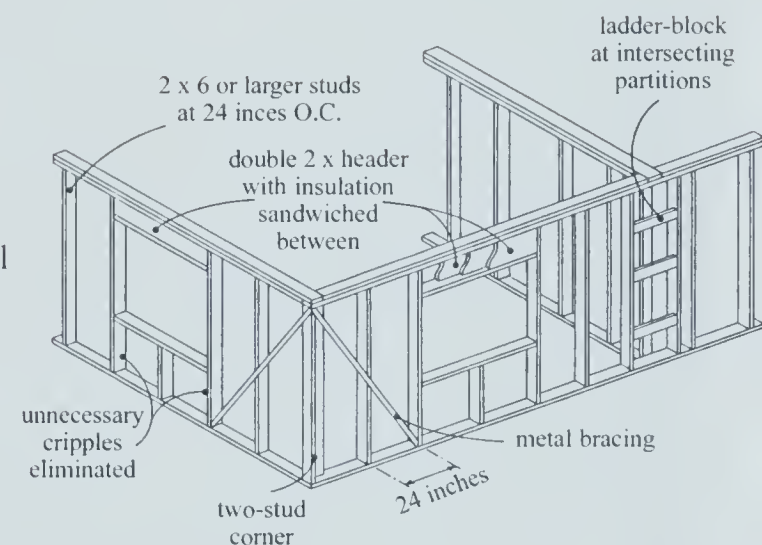
the walls. Placing foam board insulation on the interior and taping the seams with sheathing tape will also allow the insulation to serve as an air-vapor barrier.

Double stud wall

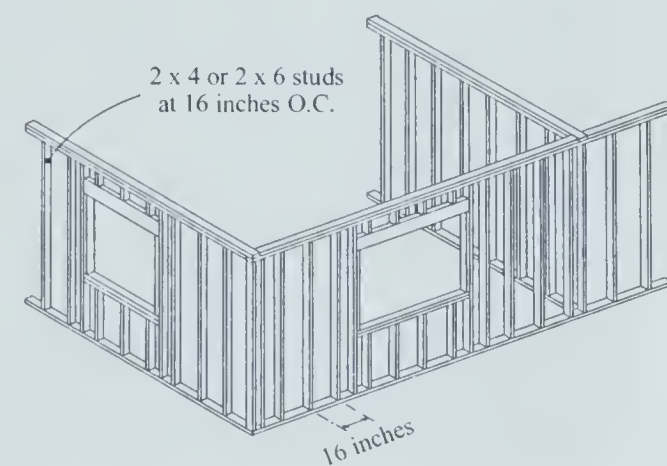
Double-wall construction provides a thick wall cavity for plenty of insulation and protects polyethylene air-vapor barriers by isolating them inside the wall assembly. A double wall normally consists of two 2 x 4 stud walls with a space between them. This space is usually 4 to 6 inches, which allows room for R11 or R19 batts between the walls and R11 batts within the cavities between studs. The polyethylene air-vapor barrier is placed on the back side of the inner wall (away from the living space). All electrical and plumbing work can be installed in the inner 2 x 4 wall without penetrating the air-vapor barrier.

Ceilings

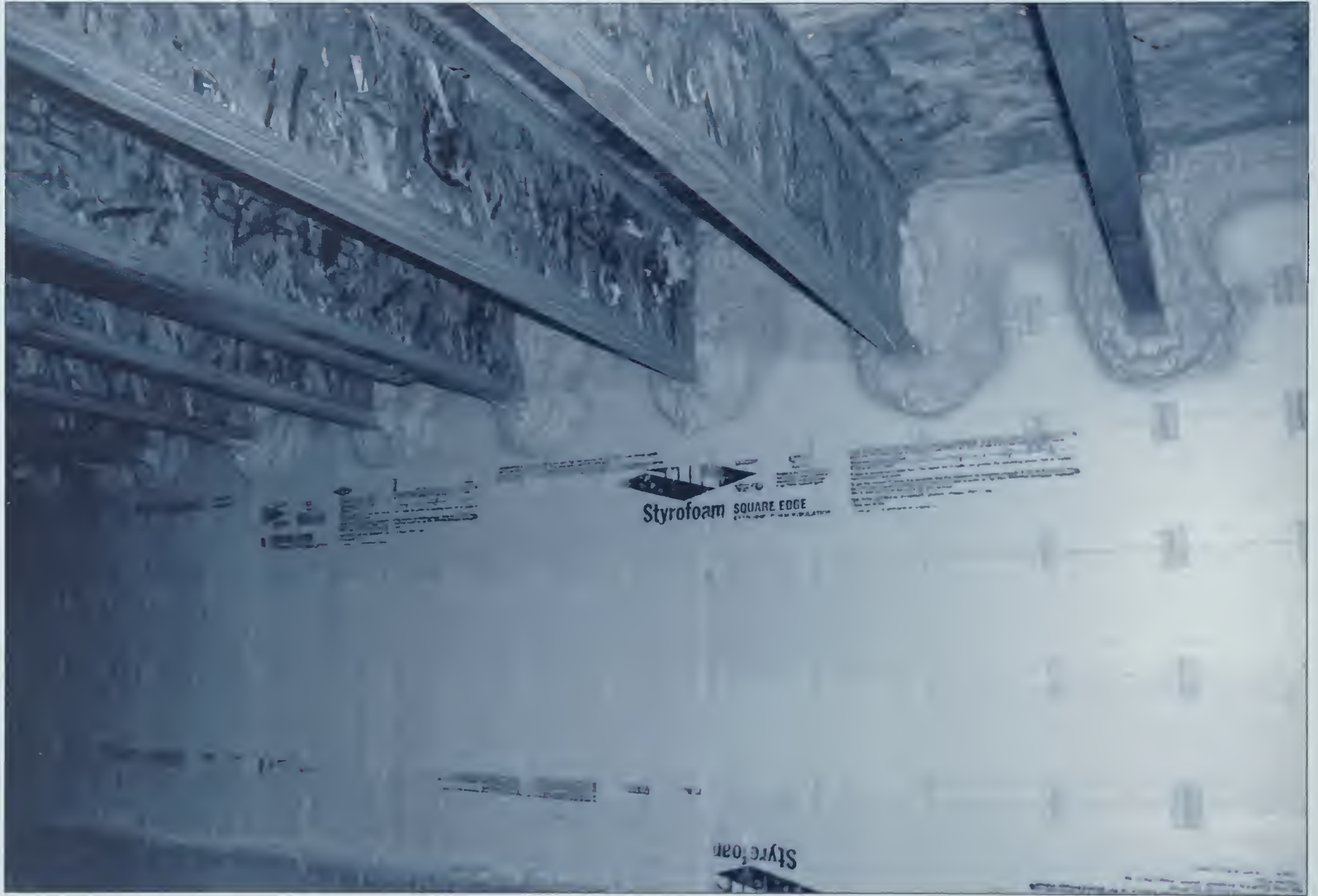
More insulation is recommended for ceilings than for walls. The attic in a house with a slanted roof and flat ceiling normally provides ample room for R40 to R60 insulation, except at the edge over the exterior walls. New houses can be built with oversized truss rafters to



Advanced Framing



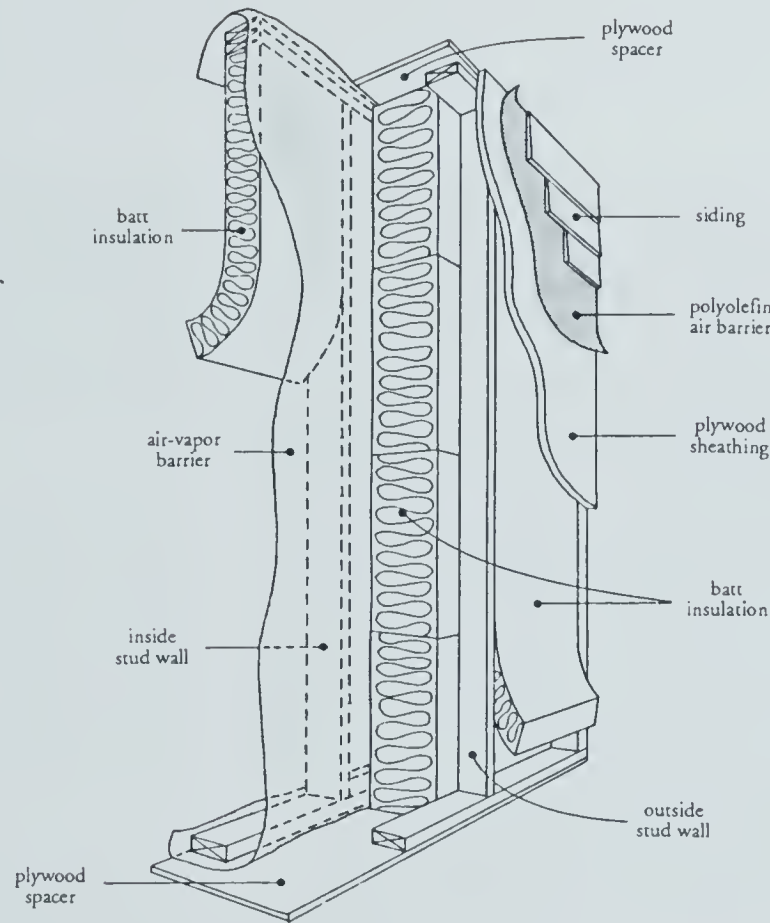
Standard Framing



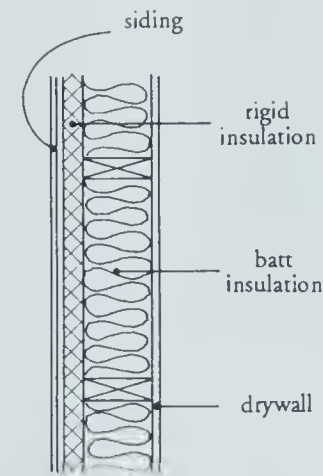
Foam Form Foundation

increase the depth at this point. In some cases, however, special framing methods at the eaves of the roof (for example, raised-heel trusses) may be required to allow full depth insulation to extend over the outside wall.

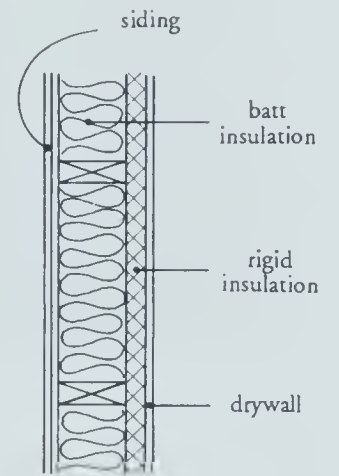
Insulation in houses with attics is usually blown-in loose fill, or batts. Insulation in cathedral ceilings can be foam or batts or a combination. The Model Energy Code minimum standard for Montana is R38. Installing more insulation than this level will save you money on your heating bills and qualifies for the tax credit.



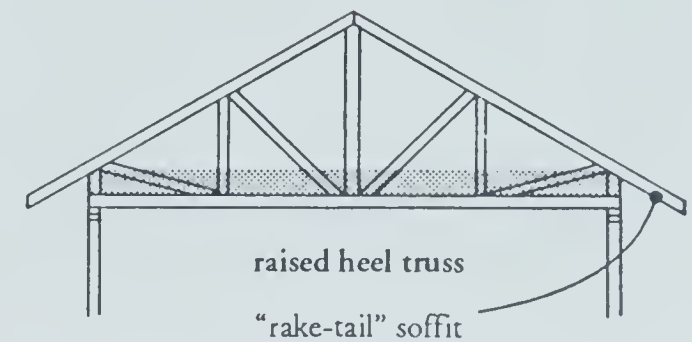
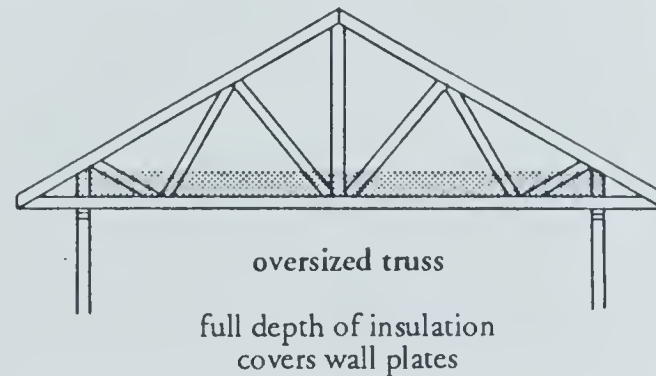
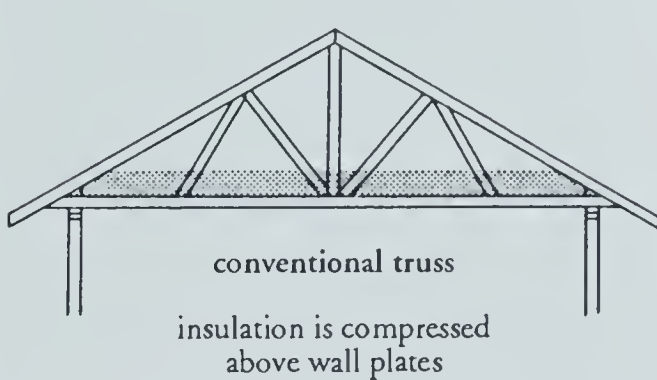
Double Stud Wall Construction



Single Stud Wall with Exterior Rigid Insulation



Single Stud Wall with Interior Rigid Insulation



Energy efficiency improvements can reduce your Montana tax bill as well as your monthly energy bills.

MONTANA ENERGY TAX INCENTIVES

Energy efficiency improvements can reduce your Montana tax bill as well as your monthly energy bills.

Add additional insulation in your new home...Purchase high performance windows...Install a high efficiency space or water heating system...and qualify for the \$500 Montana Energy Conservation Tax Credit

How does the energy conservation tax credit work?

Montana homeowners are eligible for a tax credit for a portion of the costs of installing energy conservation measures or equipment in new or existing homes. In the case of new homes, the energy conservation measures or equipment installed must exceed the Model Energy Code requirements or standard construction practice to be eligible. In simple terms, just meeting the required code minimums does not make your investments qualify for the new tax credit. The additional cost of exceeding minimum code requirements does qualify for a tax credit.

How much is the tax credit?

The amount of the tax credit is 25% of the investments you make to improve the energy efficiency of your new home or existing home. The maximum amount of credit allowed is \$500.

What types of high efficiency space heating equipment are eligible for the credit?

Furnaces eligible for the credit must exceed the minimum federal Annual Fuel Utilization Efficiency (AFUE) rating of .78 (at least 78% efficient). Most new homes today have furnace models installed that only meet the minimum required furnace efficiency rating and thus don't qualify for the credit. To qualify for the credit you must install a condensing type furnace. This type of furnace is often labeled as Energy Star qualified and will exceed the minimum AFUE requirements. Condensing furnaces have AFUE ratings from .90 to .95. High efficiency boilers should meet or exceed an AFUE rating of 85% to be eligible for the tax credit.

What types of high efficiency hot water heating equipment are eligible for the credit?

Gas storage water heaters must have an Energy Factor (EF) of .60 or higher and electric storage water heaters must have an EF of .91 or higher. The energy factor for your water heater can be found in the Consumers' Directory of Certified Efficiency Ratings for Heating and Water Heating Equipment, published by GAMA. The web version of this document is at www.gamanet.org. Instantaneous or demand type water heaters also are eligible for the credit.

Can you get a tax credit for installing energy efficient windows?

Yes, you are eligible for the tax credit if you install windows that exceed the required code minimum. The Model Energy Code requires a window U-value of .40. Windows with a lower U-value are more efficient and thus qualify for the credit. Consult the National Fenestration Rating Council (NFRC) window energy rating label that appears on the window or manufacturer literature to determine if your windows qualify for the credit.

What energy conservation investments related to insulation upgrades are eligible in new home construction?

Eligible energy conservation investments in new home construction must first exceed the Model Energy Code minimum levels to be eligible for a tax credit. The additional cost of energy conservation investments that exceed these minimum levels will thus qualify for the credit.

The statewide Model Energy Code defines the established standards of construction that must be *exceeded* if you are claiming a tax credit for new construction projects. The minimum insulation levels are as follows:

- R-38 Ceiling insulation
- R-19 Wall insulation (above-grade walls)
- R-10 Basement wall (below-grade finished basements only)
- R-19 Crawlspace floor insulation or R-19 crawlspace wall insulation
- Window U-value equal to 0.4





Are home appliances eligible for the energy conservation tax credit?

No, appliances such as refrigerators, clothes washers and dishwashers are not eligible for the tax credit. It is still a wise consumer choice to select an energy efficient appliance for your home. Shop for appliance models that carry the Energy Star label to save on operating costs over conventional appliances.

Do residential lighting fixtures qualify for the tax credit?

Yes, certain residential lighting fixtures can qualify for the tax credit. Conventional lighting fixtures that use standard incandescent light bulbs do not qualify for the credit. Lighting fixtures that use high-quality fluorescent lamps and magnetic ballasts or lighting controls can qualify for the credit. Consult the Energy Star web page at www.energystar.gov to see a listing of fluorescent lighting fixtures that qualify as energy efficient.

Compact fluorescent light bulbs by themselves are not eligible for the tax credit.

How do I apply for the credit?

You apply for the tax credit by completing tax form "ENRG-C" for individual income taxpayers. The energy conservation credit is allowed *only* for the year the energy conservation improvements are placed in service.

Who do I contact for more information?

Additional information on energy tax credits is available by contacting the Department of Revenue at 406-444-6900.

Other energy related tax benefits available to Montana taxpayers

- Geothermal heating systems - \$1,500 credit
- Alternative energy generation systems - \$500 credit
- Low-emission wood stoves - \$500 credit

Tax forms on the web

The energy conservation tax credit form and other energy related tax forms can be downloaded from the Montana Department of Revenue website at www.state.mt.us/revenue.

What other energy conservation investments are eligible for the tax credit?

Some examples of other eligible investments include:

- Insulating duct work or piping in non-heated areas above code minimums
- Insulated siding materials
- Insulated concrete forming systems
- Structural insulated panel building systems
- Programmable or set-back thermostats
- Heat recovery devices such as air-to-air heat exchangers
- High efficiency lighting fixtures

This is a partial listing of qualifying investments.



High Sierra Project – Billings

HOUSING SUCCESS STORIES

HIGH SIERRA AFFORDABLE HOUSING VENTURE

Women's Opportunity and Resource Development (WORD) of Missoula began addressing affordable housing in 1994. That was the year they started homeWORD, a support corporation specifically geared towards integrating affordability and quality into their housing projects.

HomeWORD's High Sierra Affordable Housing Venture in Billings consists of eight single-family homes. HomeWORD's approach to building projects has always been one of community involvement. The design process starts with public meetings to determine the community's priorities in housing.

"One issue that came to the forefront during our community meetings for the High Sierra project was energy efficiency," says Ren Essene, homeWORD director. "Some people told of energy costs in excess of their monthly rent. This needed to be addressed."

Architect Randy Hafer of High Plains Architects in Billings understood completely. "I had several elements I was ready to combine that could keep both building and operating costs down."

Hafer brought the goals of homeWORD to his 1280-1340 square foot two-story designs. He incorporated frost-protected foundations, structural insulated panels, and warm floor heating, along with allowing for solar heating advantages, and natural cross-circulation of rooms for cooling. All these elements combined to create a complete, affordable housing system.

FROST PROTECTED FOUNDATION

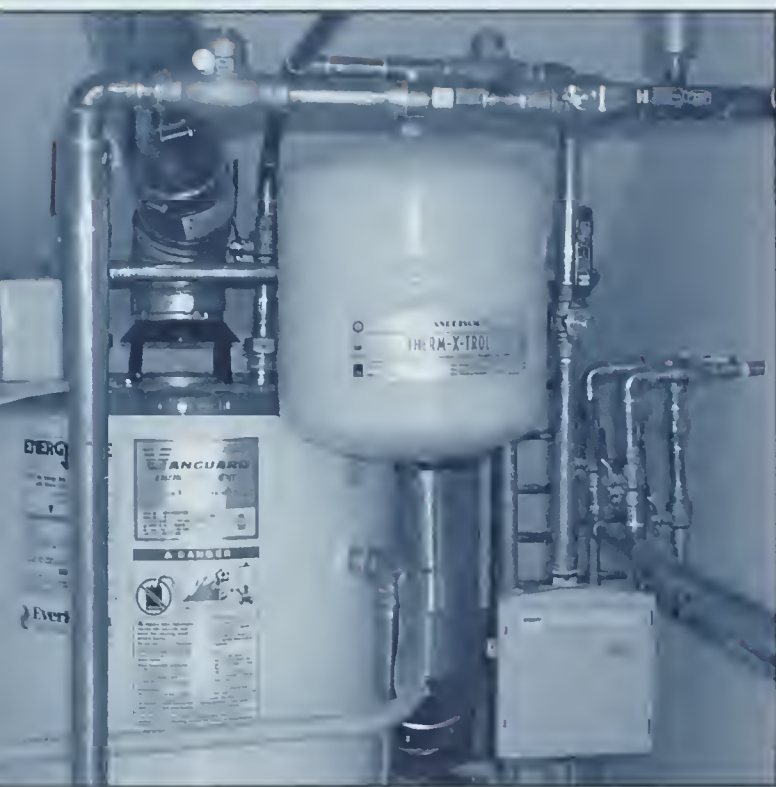
Hafer chose slab-on-grade foundations to minimize heating requirements needed for a basement or crawl space.

"Frost-protected shallow foundations are perfect for this kind of construction," Hafer said. "They minimize excavation and form work, and eliminate a lot of concrete, keeping construction costs down."

Frost-protected shallow foundations require



High Sierra Project – Billings



Radiant Floor Heating System

a flat, or at least a relatively flat, building site. Footings are dug only to sixteen to twenty-four inches, instead of the traditional forty-eight inches. This is possible because two-inch rigid insulation is installed to run down the outside wall of the foundation then extended at a right angle, horizontally away from the foundation. In the High Sierra homes, the rigid insulation extends out horizontally twenty-four inches from the foundation wall. Applied this way, the insulation forms an “L” shape against the concrete below ground level.

Insulating the foundation keeps the frost from migrating from the ground surface, traveling downward and ending up underneath the foundation where it can cause frost heaves and damage the concrete. The insulation creates a warm zone against the foundation, in essence raising the level of frost above the foundation’s base.

“Frost-protected shallow foundations are growing in popularity,” says Hafer, “because of the cost savings and also because it is environmentally less damaging since there is no need for extensive excavating. Plus they work. I’ve designed a number of houses and additions with these foundations and none have been damaged from frost heaves.”

STRUCTURAL INSULATED PANELS

From the start, Hafer designed the High Sierra homes to utilize structural insulated panels (SIPs).

“SIPs are thermally and structurally superior to traditional stick-framed construction,” says Hafer.

SIPs are built like sandwiches: polystyrene foam sandwiched between oriented strand board (OSB) skins. Whenever questions arose about using SIPs for his home designs, Hafer contacted Big Sky Insulation of Belgrade.

“A cross-link adhesive is used to bond the OSB to the foam,” says Sterling Lantz of Big Sky Insulation in Belgrade. “After it sets up, an adhesive ‘weld’ forms between the foam and the OSB. Once bonded together, the SIP is stronger than either the foam or the OSB sheets are by themselves,”

The strength of SIPs has become one of their biggest selling points. SIPs have a proven history of surviving hurricanes and earthquakes when conventional homes have crumbled. Yet for Montana, it is the thermal superiority of SIPs that give them the biggest

advantage over stud-framed construction.

In the High Sierra homes, SIPs with five-and-a-half inch EPS cores and seven-sixteenths of an inch OSB skins gave the walls an R-factor of 24, slightly more than the building code requiring walls to be an R-factor of 19. Using SIPs has advantages over stud-framed walls that use fiberglass to achieve the same R-factor.

The absence of studs provides fewer chances for heat loss. In conventionally framed walls, the studs themselves conduct heat from the inside of the house where the studs act as bridges where heat can travel almost uninterrupted to the outside of the house. This phenomenon, termed thermal bridging, is eliminated with SIPs, allowing fewer opportunities for heat loss.

Another advantage to SIPs is ease of construction. The panels come pre-fit and measured, with each wall section grooved to slide against and fit tightly to the next wall section. Each section is glued together with splines and then nailed. This makes a strong joint that doesn't sacrifice insulating properties. Many owner builders estimate they've put together the outer SIP wall sections in half the time required for stud-framed houses.

SIPs are still more expensive than conventionally-framed houses, depending on local labor costs. Some builders list expense as the number one reason they choose to remain with conventional building methods for most of their houses.

"SIPs have a higher up-front cost which is offset by reduced labor costs during construction," says Lantz. "And if you consider payback over the years through energy savings, they are more cost-effective in the long run than stick-framed houses."

Clearly, architect Randy Hafer was convinced that the benefits of structural insulated panels were significant. "I design most of my houses with SIPs in mind," he says. "Strength and thermal properties are exceptional by themselves, but when you add in an easier building process, a faster building process, and a cleaner building site with less waste lumber, I don't think they can be beaten. Environmentally, I also like the fact that no old growth lumber is needed since the OSB boards use young, small diameter trees."

"SIPs have a higher up-front cost which is offset by reduced labor costs during construction," says Lantz. "And if you consider payback over the years through energy savings, they are more cost-effective in the long run than stick-framed houses."

"Heating costs are cheaper than I expected. We're probably paying a similar amount for gas than we did in our apartment, but our house is larger."

WARM FLOOR HEATING SYSTEM

When Hafer first met with homeWORD about the High Sierra project, he suggested warm floor heat to save on installation and energy costs. HomeWORD contacted Art Fust of Energy A.D. to design the system for the High Sierra homes.

"Most warm floor heating systems use separate boilers to heat water which is then pumped through pipes imbedded in the floor," says Fust. "I've been designing systems that use the domestic hot water heater by itself and they work just fine."

Fust considers the system "low-tech" and able to be installed by even an inexperienced builder. "This is an excellent system for owner-builders," says Fust.

Diedre Soelter lives with her family in one of the homes and finds the system requires minimal adjustments to the thermostat. "I don't really adjust the thermostat much," she says. "I'll turn it down in the morning and won't usually turn it back up in the evening. When it gets real cold outside is the only time I find myself raising the thermostat."

She also appreciates the low operating costs. "Heating costs are cheaper than I expected. We're probably paying a similar amount for gas than we did in our apartment, but our house is larger."

Soelter estimates she pays about \$50 to \$60 a month for gas to operate the hot water heater. This figure represents an average over the year, allowing for seasonal fluctuations.

Soelter and her family are just one of several reaping the rewards of a heating system that is becoming more popular every year. "One thing I like about this system is that there are fewer places for drafts because there are no heater vents, which is also the reason I think there is less dust in the house. And the warm floor sure is nice on your bare feet."

COMBINING THE ELEMENTS

In the High Sierra homes, Hafer used design features that worked together to produce homes that are comfortable and affordable to operate. “A house’s envelope will always dictate heat consumption,” says Art Fust. “The better you build the house, the less heat you need to generate.”

At High Sierra, the warm floor heating system is not the only source of heat. “We oriented the homes on the building sites to take advantage of solar heating,” says Hafer, “which helps add to the overall energy savings.”

A roof overhang prevents overheating in summer, and cross-ventilation in all the rooms helps cool the homes when necessary. “Opening the windows at night in the summer should be enough to keep the houses comfortably cool,” he says.

Hafer’s designs also reflect his respect for the environment. The frost-protected shallow foundations require less soil disturbance making it possible to preserve native grasses, bushes, or trees. The SIP panels require

small diameter trees for the OSB skins, leaving old growth timber undisturbed. But in addition to these considerations, the attic insulation was also chosen, in part, for its environmental benefits. Cellulose insulation, made from shredded recycled newspaper, served the insulating role better than fiberglass.

Hafer succeeded in providing homeWORD with high quality, energy efficient designs that meet the needs of the community. The homes are comfortable, affordable, and built with a sense of minimizing environmental impact. Ultimately, it is the eight families who directly benefit. The focused effort which began with homeWORD and used countless resources in and around the community, resulted in bringing costs to a level where these eight families can now afford to live in their own homes for the first time.



Missoula Habitat for Humanity Project

MISSOULA HABITAT FOR HUMANITY

Builders are proving over and over that energy efficiency is a central component of low cost homes. Missoula's Habitat for Humanity is no exception. Missoula Habitat's saga of improving the quality of their homes for low-income families has spanned only a few years, yet they have proven that this approach works.

"We're getting better at building tight houses, that's one thing I'll say for us," says John Drake.

Drake volunteers as the construction supervisor on Missoula's latest Habitat project, a duplex designed and built to meet Energy Star requirements. The tighter houses, along with additional energy saving features, help Habitat homeowners keep energy bills lower and maintain high indoor air quality.

Habitat realized that they could and should improve the energy efficiency of their homes. With some help during construction from Mazade and the Montana Department of Environmental Quality, Missoula's next Habitat home tested at only three air changes per hour at 50 pascals. The better home featured structurally insulated panels (SIPs) instead of standard stud-framed construction. The duplex also used a heat recovery ventilator, had a foam block foundation, a high-

efficiency sealed-combustion gas furnace, and was carefully sealed with urethane foam sealant.

Some decision-makers in the Habitat for Humanity organization were not yet convinced. Since a stud-framed construction was still cheaper to build, the next two single-family homes went back to the more traditional building method.

While Habitat kept some construction features from the duplex, it was obvious that the effectiveness of the traditional insulation was not consistent. The driving force for Drake to change the construction back to SIPs was not the low cost that Big Sky Insulation was still offering to the Habitat organization. But the thermal benefits and the ease in achieving a tighter construction with SIPs couldn't be ignored.

"By that time I had worked on a few Habitat houses," Drake says, "and we had started to think in terms of how the tightness of a house converts to low energy consumption. Keeping bills down for these new homeowners is a huge benefit."

But Drake knew he had to bring the proof in dollars to the Habitat's Construction Committee before he could convince them to change.

"By that time I had worked on a few Habitat houses," Drake says, "and we had started to think in terms of how the tightness of a house converts to low energy consumption. Keeping bills down for these new homeowners is a huge benefit."

"I know it's been a gradual process for Habitat to move towards building with energy efficiency in mind," says board member, Bill De Cou. "It has helped that John Drake pushed for it so much. We've been looking more carefully at the total cost of a home instead of just the construction cost."

John Drake pushed the progression along with the power bills that Swede Gustafson, another Habitat volunteer, started to compile. From November, 2000 to January, 2002, a 15-month period, Gustafson gathered all the energy bills from the two houses. The first home was the duplex with nine air changes per hour, and the second home was the SIP-built duplex with three air changes per hour. The electricity usage was nearly identical, within \$36 of each other over the 15 months. This small cost difference was despite the difference in water heaters. The first duplex was equipped with natural gas hot water heaters, the second was equipped with electric hot water heaters. More attention had gone into choosing energy saving appliances for the second duplex and these appliances had come close to negating the extra load of the electric hot water heater.

The natural gas portion of the energy use

showed the obvious difference in appliances. Over the 15-month period, a looming \$670 difference surfaced. Unfortunately, gas hot water and heat were not separated for the first duplex so it is unknown which portion of that \$670 difference went to gas hot water and which portion of that went to heat. What is known, is the heating expense for the second, panel-built duplex. Heating expenses for both units combined totaled \$338. The first duplex spent \$1008 in gas for both units accounting for most of the difference in energy consumption between the two houses. Drake admits that parameters which can influence power usage, such as lifestyle and the number of occupants, did not enter into these figures. Even so, the energy bills still proved that the SIP-built duplex cost \$670 less to operate during the 15 month time period.

The committee agreed the \$670 savings would add up over the life of the house and make a tremendous difference to their low-income homeowners. Drake and Gustafson also emphasized that with the addition of the heat recovery ventilator and the closed-combustion furnace, the indoor air quality would greatly improve as well. Habitat is always concerned with helping families

succeed, and building with energy efficiency to provide better indoor air quality became the obvious goal to strive for.

With the committee's approval, Drake changed the next building plan to use SIP construction. Another reason Drake pushed for the change was ease of construction. Volunteers didn't have to learn how to properly install fiberglass batting.

DEQ suggested we build for an Energy Star rating," says Drake. "DEQ felt we were close to achieving Energy Star status with the last three houses. And Gary Mazade thought that with a little more work we could even exceed the standards for Energy Star."

Because Missoula's Habitat for Humanity had been improving their skills in building energy efficient homes, achieving the Energy Star rating would focus on attention to details.

Construction Details

The basic construction of the Energy Star duplex is identical to the SIP-built duplex Habitat had already built. The difference is in the little things that workers are doing during every phase of the construction.

"I think qualifying as an Energy Star home," says Drake, "makes us reach a little farther.

Energy Star

The Energy Star program began in 1992 as a labeling system to help consumers purchase energy efficient products. It offers consumers a uniform way to shop for products that have a lower impact on the environment, something that has developed into a priority for consumers. At the same time, it encourages manufacturers to improve the efficiency of their products through addressing consumers' environmental concerns. Consumers win because they have an easy way to find the products with the qualities that are important to them, and manufacturers win because more consumers seek out and buy their products. But the environment is the ultimate winner.

The Energy Star program bases all their requirements on one overriding goal: Reducing greenhouse gases in the air. The program covers nearly all products that require energy to operate, from electronics, appliances, lighting,

and home office equipment, to heating and cooling systems. Energy Star even includes new home construction.

All homes earning the Energy Star label have met US Environmental Protection Agency and Department of Energy performance guidelines. Generally, these guidelines represent a 30% improvement over Montana's minimum building codes. Builders who qualify their new houses for the Energy Star label are providing a way to differentiate the quality of their homes from the rest of the market. It is not a conservation program that asks consumers to sacrifice their lifestyle, it is about doing more with less energy for the benefit of the environment. Requiring less energy from power plants, many of which are coal-fired, reduces air pollution and reduces the need to build more power plants. The energy already produced goes farther, and can supply energy to more homes.



Money Isn't All You're Saving

Visit www.energystar.gov
for more information



Duct Sealing

Keeps us pushing for a better built house.”

The Energy Star house will be at least the fourth Habitat house built with a foam block crawlspace. A moisture barrier is placed over the ground before the foundation is poured. After the moisture barrier is in place, rigid polystyrene foam blocks two inches thick are set up as foundation forms. Concrete is carefully poured into the foam forms, the result being a concrete foundation sandwiched

between rigid R10 foam insulation.

Next the SIP panels are installed, all seams are sealed with a single component polyurethane foam or with a caulking compound. Volunteers find it easier to fit windows more snugly in the panels than in stud-built homes, but special care still must be taken to ensure no air leakage around the windows. As soon as the house can be sealed, the initial blower door test will be performed.

“Detail, inspection, and testing make the difference,” says Mazade. “As soon as we are able to perform a blower door test, we’re there to test. All the problems in the building’s envelope should be fixed before the sheetrock ever goes up. After the house is finished, it becomes much more difficult to stop air leaks.”

Another place that Drake has concentrated efforts has been the ductwork. Every joint in the heating ductwork is sealed with duct mastic, as well as the joints for the heat recovery ventilator ducts.

“We want to make sure the heat is going where it needs to be, namely the living space,” says Drake. “Sealing the ductwork is becoming more routine now, just as the foam block foundation has.”

Drake admits this duplex has had a lot fewer problems and received a lot more attention to detail because the crew of volunteers and contractors has experience with the design they are building. Less of his energy is spent explaining why each and every possible source of air leakage in the building’s envelope must be well sealed, or why elbows in the ductwork have to be wrapped or sealed.

The Families Benefit

After all of the hard work of Missoula Habitat volunteers and the homeowners themselves, families are rewarded with a high quality home, a home that requires less energy and less maintenance than most low-income houses.

“This house is one to two hundred percent better than the double-wide we used to live in,” says new homeowner Mike Robinson. “The double-wide was drafty, with cold and warm spots throughout it. This new house is tight, we can’t hear the street noises, and the whole house is comfortable, not just one room. The heat recovery ventilator distributes the heat so evenly, we don’t have rooms that are too warm or too cold anymore.”

Robinson put in 700 hours more than the 500 hours required of him during the building of his own home. He has become a resource in the community for building and operating questions for his neighbors.

“Most folks don’t understand what the ventilator does, so I make sure that they use it and don’t turn it off,” he says. Robinson and his family had recently moved into the single-family stud-built home which tested at four air changes per hour at 50 pascals.

“Building for energy efficiency is not a high-end thing,” Mazade says. “We can’t afford not to do this. Not only does using less energy help the environment, but the building will also last longer if it’s built better. If we don’t pay attention to these things, the resources we use will be wasted.”



AFFORDABLE HIGH PERFORMANCE

The National Affordable Housing Network (NAHN) in Butte is, above all else, an advocate for low-income homebuyers. NAHN has made homeownership possible to many who thought that such a goal was beyond their reach. The resources that this non-profit organization offers are not limited to low-income families. The information NAHN gathers and the home plans they've designed are available to anyone who wants low-cost energy-efficient housing.

"Our house plans are for anyone who wants to build a low-cost, but High Performance home, whether it is a first time home builder or a seasoned contractor," says NAHN Executive Director, Barbara Miller.

The NAHN staff, with more than 40 years combined experience, provides a one-stop resource for reliable research data; construction education and evaluation; and low-cost construction home designs. Their home designs concentrate on two things: affordable energy efficiency and a healthy living environment.

Affordable Efficiency

The thought that efficient homes are too expensive to build is now proven to be a myth.

"Depending on where you're starting from, the technology we use adds no more than \$3,000 'extra' cost to a minimum property standard home," says Miller. "And that money is paid back in savings in less than five years."

It may be difficult to describe what NAHN uses as "technology," since there is nothing new about it. Once known as "superinsulation," their High Performance approach has been used as an energy-conserving building method for more than 20 years.

These homes achieve High Performance characteristics by nearly doubling the insulation required by building codes. The ceiling is insulated to R60, the walls to R40, and the floor to R25. Fiberglass is blown in for the ceiling; structural insulated panels or a double stud wall with fiberglass insulation are used for the walls; and the floor has unfaced batt fiberglass. This increased insulation is partnered with a continuous barrier that reduces air leakage through the walls at the same time keeping moisture out of the inner structure of the building.

"Depending on where you're starting from, the technology we use adds no more than \$3,000 'extra' cost to a minimum property standard home," says Miller. "And that money is paid back in savings in less than five years."

“On a normal day, even the heat given off by lights and appliances can add to the supply of space heat. Because the tightness and extra insulation of the homes make them lose so little heat to begin with, even small heat sources can add significantly to the overall heating picture,” says NAHN President and Research Director, Bob Corbett.

The main heating source for these homes is a 20,000 BTU sealed combustion natural gas fireplace heater rated as a furnace. While this unit is large enough to easily heat these homes by itself even when outside temperatures fall well below zero, this furnace is not the only heat source. Several normal sized windows on the long south-facing side of these houses provide solar heating during the day. A roof overhang provides summer shading of these windows, and low-e heat rejection glazing on western windows prevents overheating in summer from sunlight entering from the west. Yet taking advantage of this extra heating source during winter months means the furnace runs less frequently.

“On a normal day, even the heat given off by lights and appliances can add to the supply of space heat. Because the tightness and extra insulation of the homes make them lose so little heat to begin with, even small heat sources can add significantly to the overall heating picture,” says NAHN President and Research Director, Bob Corbett.

Even conventionally built homes today are getting tighter and tighter. This is mostly due to improvements in building materials.

“Unfortunately,” says Corbett, “this can be

a bad thing if a builder doesn’t pay attention to ventilation and indoor air quality issues. We use a fan depressurization test on each house to find and fix any air leaks during construction so that the ventilation system can do its job efficiently.”

The heart of the ventilation system is the heat recovery ventilator (HRV). The HRV has two purposes: to mechanically ventilate the home, and to reclaim as much heat as possible. While conventionally built houses traditionally ventilate through cracks and air leaks, essentially allowing the wind to carry fresh air into the living space; homes where air leaks are minimized to a negligible level, require mechanical ventilation. The HRV continuously draws outside air into the house at a predetermined rate, distributing fresh air through ducts into each room in the home. Through this distribution, heat inside the home is equalized from floor to ceiling and from wall to wall, preventing cooler or warmer areas in different rooms, which provides greater comfort for the occupants.

As the HRV moves fresh air into each room, it simultaneously exhausts stale indoor air to the outside through a separate duct system. Before the indoor air is exhausted, the



Heat Recovery Ventilator Core



Heat Recovery Ventilator

ventilator core allows the warm indoor air to pass near the cool, incoming, fresh air. The cool air is warmed before it is released into the home, and less heat is lost as the indoor air is vented to the outside. This process recovers, on average, about 70% of the heat that would normally be lost.

LOW COST EQUALS BEST VALUE

Amy and Ron Kichline, of Butte, built their own NAHN-designed home through the Habitat for Humanity home buying program. Neither of them knew anything about home building before they started. The couple took classes taught by NAHN staff to learn the fundamentals they would need to help with construction. Then, with the help of Amy's retired carpenter father, Bill Opie, they dove into the project, eventually clocking upwards of 2,000 hours among the three of them.

"I had no carpentry or construction experience at all," says Ron Kichline. "But I had no problem helping build my own house."

MORE THAN THE SUM OF ALL PARTS

Clearly, the NAHN home designs are intended for low-income families, but anyone should be proud of these homes, and can adapt the plans to meet their needs. Since the outer walls are the only load-bearing walls, floor plans can be changed to meet personal tastes. Experts must be consulted to redesign the ventilating system when builders choose to rearrange floor plans before construction. Heating costs are low, the living environment is healthy, but it is still the little things that people notice most about these attractive homes.

"This house is so much more comfortable than the one we rented," says homeowner Amy Kichline. "We never touch the thermostat now, not even at night."

More than comfort, more than affordability, it is the pride that comes through in Amy's voice that speaks loudest. "We get lots of compliments on our house," she smiles. "And we built it with our own hands."





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